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**Perinatal Depression and Children's Developmental Outcomes at 2 and 3 Years
Postpartum**

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Philosophy in Psychiatry

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I. Declaration

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III. Summary

Depression is the most common perinatal psychiatric disorder and has been associated with a range of adverse outcomes for children, parents and overall family functioning. The current thesis sought to build on existing research by adopting a family systems perspective to examine the impact of perinatal depression and parenting behaviours on children's social-emotional, cognitive, language and adaptive behavioural outcomes at 2 and 3 years. According to the 'Developmental Origins of Health and Disease' (DOHaD) hypothesis (Barker, 1990, 2007), the antenatal period represents a critical period for the origins of later developmental outcomes. One mechanism that is posited to underlie the intrauterine influence on children's subsequent mental health is the activity of the hypothalamic-pituitary-adrenal (HPA) axis, which undergoes significant change throughout pregnancy.

The data included in the current analyses were collected at the fifth and sixth timepoints of a prospective longitudinal study, which followed participants from pregnancy through to 3 years postpartum. Women were recruited during their second or third trimester of a singleton pregnancy, and stratified into three participant groups: 1. Depressed (those with a clinical diagnosis of Major Depressive Disorder [MDD]); 2. History of Depression (those who were currently euthymic with a previous MDD episode); 3. Control (no history of psychiatric disorders). At the 2- and 3-year timepoints, mothers, fathers and their children were invited to participate in follow-up appointments based in the Trinity College Infant and Child Research Laboratory. Parental depression severity was evaluated using the Hamilton Depression Rating Scale (HAM-D), children's developmental outcomes were assessed using the Bayley Scales of Infant and Toddler Development, 3rd Edition (BSID-III), parents' and children's HPA axis activity was measured using salivary cortisol samples, and parent-child play interactions were analysed in dyadic and triadic contexts.

No direct associations between parents' depression scores and children's social-emotional, cognitive or language development were observed. When the current study examined parents' and children's HPA axis activity for markers of dysregulation associated with depression, no significant group differences were observed. However, maternal cortisol was significantly associated with children's language outcomes. The relationships between parental depression and coparenting and parenting quality were also examined, and no negative associations were observed among mothers. However, there was evidence of a cross-over effect, wherein the vocal responsiveness of mothers

and fathers was negatively associated with their partners' depression scores. The conversational balance exhibited during parent-child play interactions was positively associated with parental depression scores, as well as with children's cognitive and language scores, providing further evidence to suggest that the developmental outcomes of children in the current study were not adversely impacted by their exposure to depression. While findings based on small samples must be interpreted with great caution, the current study presents a detailed examination of parent-child interaction in the context of perinatal depression and provides avenues for future research.

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List of Abbreviations

AUCg	Area Under the Curve with respect to ground
AUCi	Area Under the Curve with respect to increase
BSID-III	Bayley Scales of Infant Development, 3 rd Edition
CAR	Cortisol Awakening Response
CBT	Cognitive Behavioural Therapy
CES-D	Center for Epidemiologic Studies - Depression Scale
CRS	Coparenting Relationship Scale
EF	Executive Function
HAM-D	Hamilton Depression Rating Scale
MDD	Major Depressive Disorder
MLT	Mean Length of Turn
MLU	Mean Length of Utterance
PSS	Perceived Stress Scale
RA	Research Assistant
SE	Social-Emotional
VOCD	Vocabulary Diversity

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Chapter 1
Introduction

1.1 Perinatal Depression

During the transition to parenthood, men and women experience significant changes to their identities and responsibilities. Their mental health is vulnerable, even among individuals who are considered to be at low risk, as it can be a demanding, albeit fulfilling, period of life (Cowan & Cowan, 2000).

Depression with peripartum onset, or perinatal depression, are terms used to describe an individual's experience of a Major Depressive Episode, during the antenatal and/ or postnatal period (Kendig et al., 2017). As with Major Depressive Disorder (MDD), diagnostic criteria are met if at least one of two core symptoms (persistent low mood and anhedonia), alongside four additional depressive symptoms, have been experienced for a minimum of two consecutive weeks (Diagnostic Statistics Manual-5th Edition [DSM-V], American Psychiatric Association, 2013). The most recent aforementioned DSM edition saw the replacement of 'Postpartum Depression' with 'Perinatal Depression' – a distinction that was required to encompass the vast number of individuals who also experience MDD during the antenatal period. The amendment to diagnostic criteria stated that depression may be characterised as 'perinatal' if an episode occurs at any point during pregnancy, up to four weeks postpartum. However, in clinical settings, the perinatal period typically extends to approximately one year postpartum (Milgrom & Gemmill, 2014).

Depression is the most common perinatal psychiatric disorder, with estimated prevalence rates ranging from 7-20% in high-income populations, and up to 30% in low-income countries (Pratt et al., 2017). The prevalence rate for maternal antenatal depression in Ireland was recently estimated at 15.8% (Jairaj et al., 2019). The likelihood of developing perinatal depressive symptoms is heightened among women who have a history of depression and prior exposure to adversity, such as abuse or trauma (Guintivano et al., 2018). If left untreated, perinatal depression can result in a range of adverse outcomes for parents, their children, and overall family functioning. The neurobiological mechanisms underlying antenatal depression and the outcomes associated with children's exposure to depressive symptoms, throughout the perinatal period, will be discussed in the upcoming sections.

1.2 Neurobiological Mechanisms of Antenatal Depression

The theory that experiences occurring during critical periods of development may significantly influence an individual's current and long-term health outcomes is known as

the ‘Developmental Origins of Health and Disease’ (DOHaD) hypothesis (Barker, 1990, 2007). Barker’s hypothesis arose from his research in the 1980s, which examined associations between low birth weight – used as a proxy measure for antenatal exposure to adversity – and heightened risk of developing cardiovascular disease during adulthood (Barker, 1986; 1995). This hypothesis posits that environmental adversity, such as inadequate nutrition and exposure to excess glucocorticoids, may have a significant impact on the organisation of biological systems, including the immune, and neuro-endocrine (hypothalamic-pituitary-adrenal axis), alongside an individual’s plasticity to adapt to environmental conditions (Van den Bergh et al., 2017).

While the DOHaD hypothesis was initially used to examine associations between intrauterine stressors and subsequent physical health issues, epidemiological research has since identified significant associations between maternal stress and offspring outcomes, including psychopathology in childhood and adulthood (Van den Bergh et al., 2017). Extensive research has confirmed the importance of examining the antenatal period, as a critical timepoint for the origins of later neurodevelopmental outcomes (Monk et al., 2019). While various factors may underlie the link between antenatal maternal factors and offspring susceptibility to psychopathology, one of the most likely mechanisms that may explain the intrauterine influence on subsequent mental health lies in the activity of the hypothalamic-pituitary-adrenal (HPA) axis, which undergoes significant change throughout pregnancy.

1.2.1 The hypothalamic-pituitary-adrenal axis

The HPA axis is our primary stress response system which stimulates physiological and behavioural adjustments that aid our restoration to homeostasis (Fries et al., 2009). This process involves the release of various hormones. Corticotropin-releasing hormone (CRH) and arginine vasopressine (AVP) are released from the hypothalamus and CRH is carried down from the brain to the pituitary through a portal blood system. This triggers the release of adrenocorticotrophic hormone (ACTH) from the pituitary gland. ACTH is then carried in the blood circulation to the adrenal cortex, which triggers the release of the glucocorticoid and stress hormone, cortisol (Fries et al., 2009). Cortisol then binds to two types of receptors: glucocorticoid receptors (GRs), found throughout the brain, and mineralocorticoid receptors (MRs), largely concentrated in the hippocampus (Booij et al., 2013). When cortisol binds to these receptors, a negative feedback loop, in which cortisol

binding to brain cells inhibits the release of further CRH is established. The consequent cessation of cortisol production following exposure to stressors prevents functional damage to the frontal lobe, amygdala and hippocampus that is associated with chronic exposure to elevated cortisol levels (Lupien et al., 1998).

While short-term stress may have an adaptive function, chronic stress intensifies cortisol production and can disrupt the typical negative feedback loop, resulting in dysregulation of the HPA axis (Hannibal & Bishop, 2014). This dysregulation may present in several ways, including a blunted stress response (Mazurka et al., 2016), and heightened baseline cortisol levels (Doolin et al., 2017). HPA axis dysregulation is typically evaluated through the measurement of salivary or blood cortisol levels.

1.2.2 The HPA axis during pregnancy

During pregnancy, the activity of the HPA axis changes substantially. Throughout the second and third trimesters, placental CRH production increases exponentially, with levels equivalent to those observed in the non-pregnant hypothalamus, during acute stress responses (Howland et al., 2017). Increased placental CRH stimulates the pituitary gland, resulting in the increased production of ACTH and cortisol (Mastorakos & Ilias, 2003). While the circadian secretion pattern of cortisol continues during pregnancy (Entringer et al., 2011), maternal basal cortisol levels increase by up to five times their non-pregnant level (Mastorakos & Ilias, 2003).

Unlike the negative feedback loop that operates via the hypothalamus outside of pregnancy, maternal and foetal cortisol stimulate CRH expression in the placenta to produce further ACTH and cortisol, in a positive feedback loop that continues over the course of gestation (Howland et al., 2017). At a critical physiological level of cortisol, a mechanism is precipitated that results in parturition, or delivery of the foetus. This means that if CRH is stimulated because of stress in the pregnant woman, then the baby will be delivered earlier (O'Keane et al., 2011).

1.2.3 The HPA axis and antenatal depression

Our stress response system is highly involved in the aetiology of depression outside of pregnancy, and displays significant plasticity during pregnancy, which may heighten a mother's susceptibility to developing depression (Dickens & Pawluski, 2018). Hence, the HPA axis is thought to play a major role in women's experience of perinatal depression.

In the antenatal period, depressed women have been found to exhibit higher cortisol levels than their non-depressed peers. O'Keane et al. (2011) found that depressed women in their second trimester had significantly higher CRH levels and higher evening salivary cortisol concentrations than a control group of non-depressed pregnant women. The authors posited that depressed pregnant women's hypersecretion of cortisol spurs the increase in placental CRH production during early pregnancy, resulting in earlier delivery of the baby.

Increased cortisol exposure is required for the maturation of foetal tissue prior to birth. The placental enzyme 11 β -Hydroxysteroid dehydrogenase type 2 (11 β HSD-2) protects the foetus from excess exposure to cortisol, through conversion to its inactive form, cortisone (Wyrwoll et al., 2015). However, researchers have argued that abnormally elevated levels of circulating cortisol may saturate placental 11 β HSD-2 and impede its ability to convert cortisol to cortisone (Xiong & Zhang, 2013). Overexposure to cortisol, associated with antenatal depression, may lead to dysregulated programming of the foetal HPA axis (Glover et al., 2009). Evidence for HPA axis dysregulation among the offspring of depressed mothers has been provided by several studies, demonstrating heightened stress responses from infancy (Brennan et al., 2008) through to early adulthood (Barry et al., 2015).

One of the primary indices used to evaluate HPA axis dysregulation is the cortisol awakening response (CAR), which constitutes an individual's physiological response to awakening. In most individuals, cortisol levels peak approximately 30 minutes after awakening, and gradually decline throughout the day (de Souza-Talarico et al., 2011). A blunted CAR has been reported in depressed individuals (Doolin et al., 2017). The current study will examine parental HPA axis activity through the evaluation of mothers' and fathers' CARs at 2 and 3 years postpartum.

1.3 Perinatal depression and children's development

The developmental domains typically examined in research relating to children's outcomes include social-emotional, cognitive and language development. These domains, and the ways in which they may be impacted by children's exposure to perinatal depression, will be discussed in the following section.

1.3.1 Perinatal depression and children's social-emotional development

Social-emotional development lays the foundation for children's understanding, processing and regulation of emotions. This developmental domain is very important to children's future well-being, as deficits and delays in this area have been associated with increased risk of psychiatric disorder in adolescence and adulthood (Madigan et al., 2018).

Throughout childhood, social-emotional outcomes are typically evaluated through parental report and observation of internalising and externalising symptoms (Wolford et al., 2019). 'Internalising' refers to children's psychological symptoms (e.g. withdrawal and depression), while 'externalising' behaviours include increased impulsivity and aggression (Zilanawala et al., 2019). Exposure to maternal depression has been associated with an increased risk of developing internalising and externalising issues during childhood and adolescence (Meaney, 2018). While such symptoms are more easily observed in these age groups, their emergence during toddlerhood has also been studied. For example, Junge and colleagues (2017) reported a strong negative association between third trimester maternal depression levels and children's social-emotional development at 2 years postpartum. Studies examining older children have provided further support for the long-term association between perinatal depression and children's outcomes. For example, Verkuyl and colleagues (2014) found that children whose mothers had depression at 6 months postpartum were twice as likely as non-exposed children to suffer externalising issues at 10 years. This effect held after adjusting for socio-economic status and current maternal depression. Similarly, Letourneau and colleagues (2013) reported a significant association between maternal depression at 2-3 years postpartum and children's anxiety at 10 years of age.

A meta-analysis conducted by Goodman and colleagues (2011) found that the association between maternal depression and children's internalising issues was greater in clinical samples than in self-report-based community samples. Theoretically, this makes sense – more severe maternal depression will lead to more adverse outcomes for children. However, there was no significant difference in effect sizes between clinical and community samples with regard to children's externalising symptoms (Goodman et al., 2011). Furthermore, Kingston and colleagues (2018) found no significant difference in the externalising symptoms displayed by 3-year-olds whose mothers had met diagnostic criteria for perinatal depression versus those whose mothers had experienced high subclinical symptom levels. Taken together, these findings support the idea that children

exposed to severe maternal depression are at increased risk of developing internalising issues, while the risk of developing externalising issues is heightened even among children whose mothers' depressive symptom severity is subclinical.

1.3.2 Children's self-regulation

An important aspect of children's social-emotional development is the advancement of their ability to regulate their emotions. Such regulation involves various cognitive and behavioural strategies that individuals use to control their emotional experiences and expressions (Kinner et al., 2014). One factor that may impede children's ability to engage in appropriate emotion regulation is their heightened reactivity to stressors (Blair, 2010). Heightened physiological and emotional reactivity may be displayed through affective symptoms, such as negative mood and disproportionate responses to stimuli, and has been identified as an early predictor of psychopathology in later childhood (Rothbart & Bates, 2006). For example, 4-month-old infants who were observer-rated as being highly reactive were found to be twice as likely to experience anxiety at the age of 7 (Kagan et al., 1999). Additionally, in studies based on parent-report, highly reactive 6-month-old infants were 1.5 times more likely to meet diagnostic criteria for psychiatric disorders at 7 years of age, compared to less reactive infants (Sayal et al., 2014).

Children who have been exposed to more severe maternal depression are more likely to display heightened physiological and emotional reactivity, and hence, deficits in self-regulation. Support for this relationship was provided by Blandon and colleagues (2008), who examined children's progress in emotion regulation from the age of 4 to 7 years. They found that children whose mothers reported fewer depressive symptoms displayed superior emotion regulation development over time, compared to peers whose mothers had experienced more depressive symptoms (Blandon et al., 2008).

1.3.3 Children's cognitive development and perinatal depression

Early developmental psychology theorists, including Chomsky and Piaget, conceptualised cognition and language as innate abilities that develop within the infant, and the parent-child relationship was typically proposed to moderate, but not directly influence, this development (Piattelli-Palmarini, 1994). Vygotsky (1978) broadened our understanding of early child development with his sociocultural theory. From this perspective, Vygotsky (1978) emphasised the influence that the quality of parent-child interactions may have on children's developmental outcomes. This social-interactionist framework has provided

the basis for a great deal of research that has focused on the social context of children's cognitive and language development (e.g., Sternberg & Williams, 1996; Leech et al., 2020).

As with social-emotional development, children's cognitive functioning has been negatively associated with their exposure to perinatal depressive symptoms. Direct associations were reported by several early perinatal depression studies. For example, Lyons-Ruth and colleagues (1986) reported lower cognitive Bayley scores among 1-year-olds whose mothers had elevated depression levels. Similarly, Murray and colleagues (1996) found that, controlling for maternal IQ, depression at six months postpartum predicted children's lower cognitive scores at 18 months.

More recently, studies have examined the influence of the timing and chronicity of maternal depressive symptoms on early childhood outcomes. Using data from the French EDEN study, van der Waerden and colleagues (2017) found that children whose mothers had chronic elevated depressive symptoms scored significantly lower on the Wechsler Preschool and Primary Scale of Intelligence Third Edition (WPPSI-III), compared to children whose mothers had never had depression. Furthermore, no cognitive deficit was observed in children whose mothers had experienced depression during the preschool period only. Such findings suggest that children are more likely to experience cognitive deficits associated with maternal depression if mothers' symptoms are persistent throughout the perinatal period. Other studies have reported no direct association between maternal depression and children's cognitive outcomes, and instead emphasised the indirect impact that depression may have on children's development, through its influence on the quality of the mother-child relationship (Chen et al., 2013; Piteo et al., 2012).

1.3.4 Children's executive function and perinatal depression

Executive function (EF) is the term used to describe the cognitive skills that underlie our ability to consciously control our thoughts and behaviours (Carlson et al., 2013). EF comprises three main components: working memory, inhibitory control and set shifting (Miyake & Friedman, 2012). Working memory enables individuals to hold and manipulate information as required (Bull et al., 2008). Inhibitory control facilitates the suppression of prepotent attentional or behavioural responses (Garon et al., 2008). Finally, set shifting refers to the ability to freely shift one's focus between different tasks (Wecker et al., 2005). Together, these skills enable individuals to achieve specific goals

(Espy et al., 2001). While EF involves higher-order cognitive skills, which were initially thought to develop during later childhood, research has provided evidence for significant improvements in EF, occurring during early childhood, particularly in the first 3-5 years of life (Bernier et al., 2012; Blair et al., 2011). These improvements can be explained by the rapid development that occurs within the prefrontal cortex during this period. By the age of 3, toddlers display significantly more attentional control than they had as infants. This skill enables them to concentrate on relevant aspects of a task and sustain their attention for prolonged periods (Garon et al., 2008). Such attentional developments provide the basis for more advanced EF skills to develop throughout childhood and adolescence.

Similar to general cognitive development, questions remain regarding the influence that perinatal depression may have on children's EF. Some studies have reported null findings (e.g. Klimes-Dougan et al., 2006; Micco et al., 2009; Rhoades et al., 2011), while others have found significant differences in EF ability between children exposed to perinatal depression and their non-exposed peers (Hughes et al., 2013; Park et al., 2018). Findings from Hughes et al.'s (2013) longitudinal study, examining maternal depression and children's EF from 2 to 6 years postpartum, suggested that potential effects largely depend on the chronicity of maternal depressive symptoms. Reductions in maternal depressive symptoms over time were found to predict subsequent improvements in children's EF ability (Hughes et al., 2013).

1.3.5 Children's language development and perinatal depression

Perinatal depression has been negatively implicated in children's language outcomes (Aoyagi & Tsuchiya, 2019; Feldman & Eidelman, 2009; Sutter-Dallay et al., 2011). However, there is a lack of consensus across the literature, with several studies reporting no significant direct association between the two variables (e.g. Kaplan et al., 2014; Keim et al., 2011; Stein et al., 2008). Most studies that have found a significant negative association between maternal perinatal depression and children's linguistic functioning have attributed this finding to the lower rate of learning-supportive or 'scaffolding' parenting behaviours, typically observed in studies of depressed mothers, which results in deficits to children's information-processing of their environment (Kaplan et al., 2014).

Additionally, as with children's cognitive and EF development, more recent research has emphasised the importance of examining the chronicity of depressive symptoms when predicting the magnitude of effect that children may experience in their

language development. For example, in a study examining maternal depression from 5 months to 5 years postpartum, Ahun and colleagues (2017) found that children whose mothers had experienced chronic maternal depression had lower language scores than children who were exposed to no maternal depression or depression that occurred within the first year and a half postpartum, when assessed at 5, 6 and 10 years of age.

Furthermore, Letourneau and colleagues (2013) compared 10,033 mothers by postnatal depression trajectory and found that 4-5-year-old children of mothers who had experienced either recurrent depression or depression that first emerged after the postnatal period were at increased risk of poorer language outcomes. Importantly, children of mothers who experienced depression in the initial postnatal period only were not at increased risk for language deficits (Letourneau et al., 2013). Taken together, it seems that depression is more likely to adversely impact children's language development in cases where maternal depressive symptoms persist throughout the perinatal period or emerge later, during the first 3-5 years of a child's life.

1.4 Continued programming in the postnatal environment

While the concept of programming initially focussed on the intrauterine environment, the protracted nature of human brain development means that the postpartum period constitutes a time of further programming opportunities and subsequent effects on children's outcomes (Buss et al., 2012). The most influential environmental input that a child receives in their early years stems from the quality of their home environment and their caregivers' parenting behaviours (Topping et al., 2013). The importance of these parenting behaviours may be examined from a social-interactionist perspective (Vygotsky, 1978).

One of the most influential aspects of Vygotsky's (1978) work is the concept of the zone of proximal development. This term describes the difference between what a child can do with parental guidance versus what they can do independently (McLeod, 2012). According to Vygotsky, children's long-term outcomes depend significantly on the guidance provided by adults in the zone of proximal development. This zone is created by parents who mediate children's learning by providing guidance that is reflective of their cultural values. Wood and colleagues (1976) expanded on this theory to introduce the concept of 'scaffolding', which refers to the process whereby parents engage in supportive behaviours that guide a child's problem-solving, while gradually adjusting their level of support over time, in response to the child's developing skills and autonomy.

Depression is negatively associated with the home environment and parenting quality, due to its interference in parents' abilities to provide appropriate support or "scaffolding" in response to children's emotions and behaviours (Kaplan et al., 2014). In the following section, we will discuss specific aspects of parenting that have been implicated in child development, and how such parenting qualities can be adversely affected by depression. Finally, we will discuss the moderating role of parenting quality in the relationship between perinatal depression exposure and children's outcomes, and how developmental deficits associated with maternal depression can be attenuated by a supportive home environment.

1.4.1 Mother-child interactions and perinatal depression

Parent-child interactions provide the basis for young children's understanding of social interactions in the world. As such, parents play a crucial role in fostering a home environment that provides challenges to their child, while also engaging in appropriate scaffolding behaviours, to support their child's learning and emotion regulation (Foster et al., 2008).

The adverse child outcomes associated with exposure to perinatal depression may be exacerbated by issues within mother-child interactions (McAndrew, 2017). Depressed mothers tend to engage in less frequent touch and joint attention, and use child-directed speech less effectively, compared to non-depressed mothers. The commonality of such tendencies among depressed mothers supports Tronick and Reck's (2009) model, which conceptualises maternal depression as a transmittable disorder. According to this model, depression negatively impacts mother-child communication, and in turn, distorts the child's experiences with their environment. While coordination issues can occur in any parent-child interaction, regardless of parental mental health status, any periods of affective or behavioural mismatching within non-depressed mother-child interactions are typically rectified quickly and returned to a matching state between mother and child (Tronick & Reck, 2009). However, during interactions between depressed mothers and their children, mothers' reparation process following mismatching generally does not occur as efficiently, and a greater proportion of the interaction is spent in a state of negative affect (Terrone & Santona, 2013). Tronick and Reck (2009) posited that this process may lead the child to develop a negatively-valenced view of their mother.

Alongside the impact that depression may have on mothers' ability to engage in positive affective matching, it may also impede their use of appropriate touch and gaze

behaviours (McAndrew, 2017). Such aspects of parenting behaviour are considered to be fundamental to positive parent-child interactions. Maternal touch aids in children's emotion regulation and coordinated parent-child gaze promotes healthy social communication (McAndrew, 2017). Granat and colleagues (2017) found that depressed mothers engaged in significantly less social gaze coordination and touch synchrony with their children compared to non-depressed mothers.

1.4.2 Mother-child synchrony in the postnatal environment

Synchrony is the term used to describe the coordinated social exchanges that occur during parent-child interactions (Leclère et al., 2014). Biological mother-child synchrony begins during pregnancy and is postnatally observed in the symbolic exchange that occurs between parents and their children (Feldman, 2007). Synchronous interactions rely on responsiveness from both parent and child, and adequate emotional capacity to provide each other with appropriate responses (Leclère et al., 2014; Stein et al., 2018). The current study will examine three features of parenting behaviours that have been identified as important factors underlying the quality of parent-child interactions: parental warmth, responsiveness and effective use of child-directed speech. These parenting behaviours will be discussed in the upcoming subsections.

1.4.3 Parental warmth and perinatal depression

Parental warmth is the term used to describe caregiving behaviours that display affection, enthusiasm and support towards their child (Roggman et al., 2013). Parental warmth has been linked to enhanced social-emotional and cognitive offspring outcomes during childhood (Baker, 2018) and adulthood (Maselko et al., 2011). Conversely, low parental warmth is associated with increased risk of developing externalising issues (Buschgens et al., 2010), and psychopathology, including anxiety and depression (Anderson et al., 2021; McLeod et al., 2007). While warmth displayed by either parent may positively influence children's outcomes, Pinquart's (2017) meta-analysis noted the lack of studies that have examined fathers' warmth and its relationship with children's development.

Research examining depression and parenting behaviours has provided evidence for the negative impact that depression can have on mothers' ability to engage in positive parenting, including warmth (Baker, 2018; Hummel et al., 2015; Lovejoy et al., 2000). Examination of the cognitive patterns associated with depression may elucidate the basis for this link (Gotlib & Joormann, 2010). Depressed individuals have a greater tendency to

experience heightened self-focus; this increased self-focus may hinder parents' ability to engage in warm, child-focused parenting, compared to non-depressed parents. For example, Humphreys et al. (2018) reported a significant association between maternal depression and increased self-focus in a study examining mothers' narratives about their children. Furthermore, this self-focus mediated the relationship between maternal depression and reduced warmth during a mother-child play interaction (Humphreys et al., 2018). The current study will examine group differences in the global warmth ratings given to mothers and fathers across participant groups and investigate associations between parental warmth and children's developmental outcomes.

1.4.4 Parental responsiveness and perinatal depression

Another important aspect of caregiving in the postnatal period is responsiveness. Parental responsiveness is often interchanged with the term 'sensitivity,' and is characterised by a warm, receptive, interactional style that provides appropriate responses to children's needs and signals (Wade et al., 2018). Contingent responsiveness, then, refers to the extent to which parents' responses to their children's cues are prompt and appropriate (Bornstein et al., 2008). While responsiveness can be examined across various parenting dimensions, many responsiveness studies have focused on the responsiveness of parents' vocalisations, which has been identified as a significant predictor of children's language development and social communicative skills (Edmunds et al., 2019; Marklund et al., 2015).

The three core factors that have been proposed to explain the level of responsiveness displayed by parents are their psychological well-being, children's characteristics (particularly temperament), and environmental factors, including social support (Belsky, 1984; Bornstein, 2015). Considering each of these factors, perinatal depression: negatively impacts parental well-being; tends to increase the likelihood of infants' having a difficult temperament (Davis et al., 2007); and is associated with lower social support among parents (Biaggi et al., 2016). By deconstructing the components underlying responsiveness, it is logical that this parenting quality may be significantly impacted by depression. The current study will examine the temporal quality of vocal responsiveness and compare the likelihood that depressed and non-depressed parents provided prompt responses to their children's vocalisations during play interactions. Furthermore, we will examine the influence that such contingent vocal responsiveness may have on children's developmental outcomes.

1.4.5 Maternal child-directed speech and perinatal depression

While children's understanding of language begins to develop during early infancy, their ability to coherently express language typically emerges at approximately 1 year, with significant advances in both receptive and expressive language ability occurring throughout toddlerhood. The progress that children make in their language-learning depends largely on the input they receive in their home environment (Tamis-LeMonda et al., 2001). Several aspects of maternal language have been identified as playing a key role in children's language development, including the quantity, quality and contingency of speech used during mother-child interactions (Hart & Risley, 1995; Hirsh-Pasek, 2015).

The quantity of parental speech input has been found to predict children's vocabulary growth rate (Hart & Risley, 1995). While this aspect of parental language continues to be a key factor examined in parents' language, more recent research has provided support for the importance of parental speech quantity in 2-year-olds' language development, while it appears that parental language quality may be more important to 3-year-olds' development (Rowe, 2012). Parents' language quality is typically assessed through the diversity of vocabulary produced (DeBoer, 2014). Parents' use of diverse language has been associated with a wider vocabulary among toddlers (Pan et al., 2005).

Both the quantity and quality of mothers' language may be adversely impacted by depression. Compared to those without depression, depressed mothers tend to talk less to their children (Lovejoy et al., 2000). The effects of less speech input may underlie the delayed "perceptual commitment" to one's native language that has been observed among depressed mothers' infants (Weikum et al., 2012). While every child is born with the ability to discriminate non-native phonemes, this tends to diminish towards the end of the first year, as infants have been exposed to sufficient parental speech to commit to their native language. However, 10-month-old infants of depressed mothers display significantly greater ability to distinguish non-native phonemes compared to their peers with non-depressed mothers (Weikum et al., 2012). Significant associations between native phoneme discrimination and later language development have been found (Werker & Yeung, 2005). Hence, reduced quantity of parental language, and a resultant delay in infants' commitment to their native language, may represent a key factor underlying language deficits observed in children of depressed mothers.

Depression may adversely impact the quantity and quality of mothers' language due to common symptoms such as withdrawal and disengagement, as such behavioural changes are likely to reduce individuals' speech production in general. Some depressed

individuals have been found to talk more slowly, and leave prolonged silences between speech, both of which would also reduce the language produced by depressed mothers (Rowe et al., 2005). Furthermore, while less research has examined the impact of maternal depression on their language quality, Rowe and colleagues (2005) reported a significant negative association between maternal depression and mothers' diversity of vocabulary.

Another important feature of parents' language is the tone of voice used. When talking to their children, parents tend to deliver their simplified infant- (IDS) or child-directed speech (CDS) in a 'sing-song' style, with wide variations in pitch and exaggerated vowels (Spinelli et al., 2017). Infant- or child-directed speech is very important for both linguistic and social skill development, as the variations in pitch serve to sustain children's attention (Spinelli et al., 2017) and support greater engagement during interactions with other children and adults (Golinkoff et al., 2015). In a study examining differences in the quality of mothers' IDS, those who used greater pitch variation reported greater expressive ability in their 1-year-olds (Porritt et al., 2014). In line with such findings, infants who have been exposed to less IDS in general, have been found to be respond less during social interactions, and display language deficits at 2 years (Ramírez-Esparza et al., 2017).

While most studies on parental speech style have focused on young infant samples, some studies have examined the importance of parents' vocal style among older infants. In Ma and colleagues' (2011) study, 21-month-olds exposed to novel words in either IDS or standard speech were found to learn words more easily when they were presented in IDS. However, 21-month-olds, who had a large vocabulary to begin with, and another group of 27-month-old infants were also able to learn novel words delivered in standard speech (Ma et al., 2011). In another study of novel word learning, Roseberry et al. (2014) studied three groups of 24-30 month-old children: one group was exposed to novel words during a face-to-face interaction with the experimenter, another was presented with novel words via a video chat, and the third group was shown a pre-recorded video presenting the novel words. Children learned words more efficiently in the contingent interactions compared to the non-contingent video condition. Taken together, it seems that the importance of child-directed speech in facilitating vocabulary-learning is more important to younger children who have a more limited range of vocabulary (Ma et al., 2011). However, while children seem capable of learning new vocabulary as easily

through a standard speech style, their learning continues to benefit from contingent social interactions (Roseberry et al., 2014).

Depressed mothers have been found to use less effective infant- and child-directed speech than non-depressed mothers (Kaplan et al., 2014). While mothers' use of this vocal style decreases from toddlerhood to childhood, depressed mothers have been found to use less CDS even during infancy. For example, in a study of mother-infant play interactions, Lam-Cassettari and Kohlhoff (2020) found that non-depressed mothers produced a higher vocal pitch and greater range and provided faster verbal responses when interacting with their 6-month-olds than depressed mothers. Kaplan et al. (2002) investigated the effects of this flatter prosody on infants' learning and found that while infants of non-depressed mothers readily learned that their mothers' speech signalled a face, depressed mothers' infants failed to make this connection. However, these infants showed the same learning ability when exposed to IDS produced by an unknown non-depressed mother. These findings suggest that the impact of depression on mothers' ability to produce infant- or child-directed speech may significantly interfere with their child's early learning, and the basis for future cognitive and language development (Kaplan et al., 2002). While the prosodic analysis of child-directed speech is beyond the scope of the current thesis, the quantity and quality of language produced by parents and their children will be examined, as well as the overall conversational balance, which – to the author's knowledge – has not been previously examined in both mother- and father-child play in the context of perinatal depression.

1.4.6 The moderating role of parenting on children's outcomes

Social-emotional outcomes

One of the most important aspects of social-emotional development lies in children's development of adaptive strategies to aid in their emotional self-regulation, following exposure to stressful situations. Several studies that have examined the self-regulation process in young children have found differences among the children of depressed mothers. More severely depressed mothers tend to use more maladaptive regulatory strategies than mothers with mild depression and non-depressed mothers. Maladaptive strategies are consequently more likely to be used by offspring who, by early childhood, have repeatedly observed their mothers' reactions to stressful situations (Morris et al., 2007).

Maladaptive strategies that have been observed in depressed mothers and their children include prolonged focus on the source of distress (Feng et al., 2008; Silk et al., 2006). This strategy is posited to develop among children due to their observations of their mother's rumination regarding distressing topics. Furthermore, as children get older, depressed mothers may engage them in co-rumination, with Grimbos and colleagues (2013) finding that depressed mothers of 7-to-12-year-old children participated in more discussions focused on negative emotions, during a task designed to elicit positive affect. Such parenting behaviour may adversely impact children's social-emotional development in two ways: first, through the direct effect it has on their ability to self-regulate, and second, on their behaviour, as research has identified a significant association between co-rumination and both internalising and externalising issues (Grimbos et al., 2013). In the longer term, prolonged focus on causes of distress has been found to predict depression and suicidal ideation in adolescence and adulthood (Miranda et al., 2013).

Cognitive outcomes

While some studies have provided evidence of the existence of a direct pathway from perinatal depression exposure to children's cognitive deficits, another way in which cognitive development may be impacted by perinatal depression is through its influence on depressed caregivers' parenting. The lower rate of contingent responsiveness that has been observed among depressed mothers is associated with lower performance on learning tasks (Dunst et al., 2007; Yan & Dix, 2016). Furthermore, the higher rate of negative affect displayed by depressed mothers is another factor that may impede children's learning. Infants tend to mirror their mothers' affect, and infants' own negative affect has been found to interfere with their information-processing ability (Singer & Fagen, 1992). Another way that parents' behaviour may significantly impact cognitive outcomes is in the level of parental investment provided to children. In Wu and colleagues' (2018) longitudinal study of depressed mothers' investment in their children's development, severely depressed mothers were found to provide less emotional and material support at every timepoint (1, 5, 10, and 16 years), which was significantly related to children's lower IQ scores (Wu et al., 2018).

Executive function outcomes

The development of higher-order cognitive skills – executive function (EF) – has also been examined in relation to parenting behaviours. Due to the rapid cognitive gains that

occur from infancy to toddlerhood, children's EF development is posited to be particularly susceptible to the quality of their postnatal environmental input (Kelly et al., 2020). As with other developmental domains, both cross-sectional and longitudinal research has provided consistent support for the link between mothers' engagement in responsive parenting and enhanced EF development during toddlerhood (Blair et al., 2014; Hammond et al., 2012; Hughes & Ensor, 2009; Swingler et al., 2015). Parental responsiveness throughout the perinatal period seems to be important to subsequent EF development; in Blair and colleagues' (2011) study, responsiveness at 6, 15 and 24 months was significantly positively associated with children's EF ability at 36 months.

In contrast, harsh parenting has been found to predict lower EF performance (Gueron-Sela et al., 2017). Harsh parenting is posited to impede children's ability to independently direct their attention and practice purposeful goal-driven behaviour, both of which are considered important antecedents to further EF development (Graziano et al., 2010). Consistent with previous research, Gueron-Sela and colleagues (2018) identified mothers' observed engagement in harsh-intrusive parenting as a significant mediator in the negative association between maternal depression at 2 years and children's EF ability at 4 years. While such findings suggest that maladaptive parenting associated with maternal depression may significantly impact children's EF development, Hughes et al. (2013) found that reductions in maternal depression from 2- to 6-years postpartum were associated with subsequent improvements in children's EF ability. This finding provides support for the view that EF may be particularly susceptible to reaping significant benefits from improvements in the postnatal environment, throughout early childhood.

Language outcomes

The relationship between exposure to perinatal depression and subsequent language outcomes appears to significantly depend upon the quality of parental input provided to a child. This is evidenced by several studies that have found a significant indirect link between the two variables (Stein et al., 2008; Kaplan et al., 2014). For example, in the large-scale NICHD Early Research Network longitudinal study (1999), children who had been exposed to chronic elevated maternal depressive symptoms from infancy to toddlerhood had significantly lower expressive language scores. However, this effect was found to be significantly mediated by ratings of maternal responsiveness during play interactions. Stein and colleagues' (2008) longitudinal study reported similar findings,

with structured equation modelling suggesting that the significant negative effect of maternal depression on children's language outcomes was mediated by the impact that depression had had on mothers' early observed parenting quality (Stein et al., 2008).

Aside from specific qualities of positive parenting, children's language development is also thought to be significantly influenced by parents' frequent engagement in games and reading (Conners-Burrow et al., 2014). Toddlers reap significant learning benefits from a stimulating home environment. However, such practices tend to occur at a lower rate in families affected by maternal depression (Kavanaugh et al., 2006).

1.4.7 'Plasticity' of parenting quality

While many studies have provided evidence for the adverse developmental outcomes that may result from exposure to perinatal depression, it is important to acknowledge the heterogeneity of maternal depression and the wide variation in parenting quality observed among mothers with depression. Many mothers, particularly those with milder forms of depression, are capable of engaging in responsive, scaffolding behaviours and have predominantly positive interactions with their children.

Furthermore, substantial support has emerged for the efficacy of several parenting-based interventions in reducing the adverse caregiving behaviours associated with maternal depression. Some interventions were developed for use in the wider population and have been revised to improve their relevance to depressed parents. In Goodman and Garber's (2017) review of such interventions, one program, Triple P, was modified to support parents' acquisition of positive coping skills and was found to have positive effects on depressed parents of children from early childhood through to adolescence (Sanders et al., 2008). Other interventions, designed to elicit specific positive parenting behaviours have shown subsequent decreases in children's psychopathology (Compas et al. 2011; Wolchik et al. 2002, as cited by Goodman et al., 2020). In line with a transactional perspective on development (Sameroff, 2009), reductions in children's psychopathology may then lead to reductions in parents' depression, as was observed in Compas and colleagues' (2011) study.

1.5 Paternal perinatal depression

The majority of studies examining associations between perinatal depression and children's development has focused on the impact of maternal depression on children.

This focus is sensible, given that mothers have traditionally filled the primary caregiving role, across cultures (Bornstein, 2012). However, more recent research has widened its focus to include fathers in their investigations of perinatal depression. While data on fathers are limited in comparison to mothers, several epidemiological studies have suggested that approximately 10% of fathers may suffer from depression during the perinatal period, while significant increases in prevalence rates have been observed at approximately 3-6 months postpartum (Giallo et al., 2013; Paulson & Bazemore, 2010). The prevalence rate of paternal postnatal depression in Ireland was recently estimated at 12% (Philpott & Corcoran, 2018). Compared to research examining mothers' depressive experiences, the literature examining paternal perinatal depression and its potential impact on children's outcomes remains in its infancy. However, existing literature indicates that paternal depression may also have a significant impact on children's developmental outcomes.

Current research suggests that children of depressed fathers may be at significantly heightened risk of experiencing emotional and behavioural issues, even after controlling for maternal depression (Fletcher et al., 2011; Ramchandani et al., 2005; Ramchandani et al., 2008). Significant associations between paternal depression and psychosocial deficits have been observed among toddlers (Ramchandani et al., 2008) and adolescents (Sweeney and MacBeth, 2016). In Sweeney and MacBeth's (2016) systematic review, paternal depression in both the antenatal and postnatal periods was significantly associated with offspring internalising and externalising symptoms during adolescence. Furthermore, differential effects depending on child gender have been observed; Fletcher and colleagues (2011) reported increased hyperactivity in boys, and social deficits in girls, compared to children of non-depressed fathers.

As is the case with maternal depression, paternal depression may adversely affect fathers' ability to engage in positive parenting, which may also negatively impact children's outcomes. However, it is also important to examine the positive impact that fathers can have on children's early development. For children with depressed mothers, non-depressed fathers may play an important compensatory role in their development, and hence, may help to mitigate the adverse outcomes associated with children's exposure to maternal depression. The following sections will discuss the potential buffering effect that fathers' positive parenting behaviours may have on the social-emotional, cognitive and language outcomes of children exposed to maternal depression.

1.5.1 Fathers' potential compensatory role in children's development

One facet of the unique role that fathers are proposed to play in their children's early development can be observed in the distinct play style they tend to engage in during interactions with their children. Father-child interactions typically involve more physical, 'rough and tumble' play, compared to the face-to-face conversational style typically displayed by mothers (Paquette, 2004; Yogman & Garfield, 2016). Paquette (2004) proposed that this play style is linked to the father-child 'activation relationship', wherein fathers encourage children's increased risk-taking and independent exploration of their environment. Father-child play is typically fast-moving, involving the rapid changing of rules as the interaction evolves, thus demanding the child's quick adjustment to changing conditions (Parker & Wang, 2013). Such interactions are proposed to teach children about decision-making (Yogman & Garfield, 2016) and increase their confidence (Paquette, 2004).

While Paquette (2004) emphasised the differences in physicality and tempo observed in mother- versus father-child play, Roggman (2004) proposed that there is also significant overlap between both parents. Mother- and father-child interactions typically display similar levels of warmth and conventional play interaction (Goldberg et al., 2002, as cited by Roggman, 2004). While fathers do tend to engage in more physical play than mothers, they have also been observed to range from quiet, relaxed play to boisterous physical play (Roggman et al., 2002). Mothers have also been found to vary their play style during interactions and so, children may experience high levels of positive arousal during play with either parent (StGeorge et al., 2018). However, the positive arousal elicited in play interactions with fathers tends to occur in shorter, more intense bursts, which follow an unexpected pattern as opposed to the cyclic pattern typical of mother-child play interactions (StGeorge et al., 2018). It has been posited that young children display higher rates of positive affect during father-child play due to the greater stimulation caused by the less organised pattern of positive affect (Lamb, 1981; Feldman, 2003). While research relating to father-child synchrony is limited, differences in children's arousal patterns during both types of dyadic play are proposed to represent different co-regulation processes that occur during each parents' dyadic interactions (Feldman, 2003).

There have been various conceptualisations of paternal involvement. When the term was first used in research in the 1980s, it described more basic aspects of a father's role, such as the proportion of time they were present in the home. However, fathers have

since adopted a more active role in parenting, which has resulted in modifications to the original definition. Lamb (2004) defined father involvement as comprising three core components: positive engagement in activities, responsive and warm parenting, and control (referring to paternal monitoring of the child's whereabouts and participation in decision-making regarding the child). Longitudinal data examining the impact of paternal involvement on children's development provides support to the view that positive father involvement, from the antenatal period through to adulthood, are significant predictors of children's positive psychosocial outcomes (Sarkadi et al., 2008; Yogman & Garfield, 2016). Father involvement may also positively influence children through the emotional support that fathers provide to mothers (Lamb, 2010). Partner support is associated with increased well-being, and hence, may help to alleviate certain maternal depressive symptoms, which may lead to more positive child outcomes (Feldman, 2007).

1.5.2 Fathers' buffering effect on children's social-emotional outcomes

Like maternal responsiveness, responsive fathering is associated with positive child outcomes, including greater social skills throughout childhood, lower levels of conflict, and superior emotion regulation (Brown et al., 2012; Feldman et al., 2013; Lamb, 2010). Using data from the ALSPAC study, Opondo and colleagues (2016) found that children whose fathers were rated as highly responsive when they were 8 months old had 14% lower adjusted odds of having behavioural issues at 9 years of age. In Vakrat et al.'s (2018) 6-year longitudinal study of maternal depression, the likelihood of having a psychiatric disorder at 6 years of age was four times greater among children of depressed mothers, compared to children of non-depressed mothers. However, this risk was reduced by half among depression-exposed children who received responsive fathering. This effect was only observed in children whose mothers had experienced chronic depression from birth to 6 years postpartum, and not those in the never-depressed group (Vakrat et al., 2018). This finding highlights the important buffering role that fathers may play in families affected by maternal depression.

However, it is also important to note differences in paternal responsiveness among fathers who have depressed partners versus those who do not. While fathers may help to compensate for parenting deficits associated with maternal depression, several studies have reported significantly lower levels of responsiveness in non-depressed fathers who have a depressed partner compared to fathers who have a non-depressed partner (Goodman, 2008; Goodman et al., 2011; Vakrat et al., 2018). This context places the

child at higher risk of experiencing adverse developmental outcomes. Several theories may explain the roots of this phenomenon. According to ‘assortative mating’ theory, depressed women may enter into relationships with less adaptive individuals (Marmorstein et al., 2004). Furthermore, it has been proposed that fathers may learn how to respond to their children from observing mothers, and reduced responsiveness associated with maternal depression may provide maladaptive modelling of caregiving behaviours to their partners (Feldman & Klein, 2003).

Another possible mechanism underlying the lower responsiveness observed in fathers with depressed partners is that attempting to compensate for deficits in maternal caregiving is difficult to sustain overtime, particularly if a couple has several children to parent. However, Vakrat and colleagues (2018) found that while paternal responsiveness was generally lower among fathers with a depressed partner compared to fathers with a non-depressed partner, children’s risk of developing psychopathology was still significantly reduced when fathers displayed moderate responsiveness compared to children who were exposed to maternal depression alongside significantly lower paternal responsiveness. Taken together, it appears that fathers of children with depressed mothers may have a lower likelihood of engaging in responsive parenting, compared to fathers with non-depressed partners. However, fathers who are able to develop a responsive parenting style can play a major role in mitigating the adverse effects associated with low maternal responsiveness and subsequent child outcomes.

1.5.3 Fathers’ buffering effect on children’s cognitive and language outcomes

Fathers’ responsive parenting is not only associated with positive outcomes for children’s social-emotional development but may also significantly influence their cognitive and language outcomes. Responsive parenting by fathers has been found to independently account for variation in children’s current and subsequent cognitive scores, in 2- and 3-year-olds, as measured by the Bayley Scales of Infant Development (BSID-II) (Tamis-LeMonda et al., 2004; Cabrera et al., 2007). Furthermore, Towe-Goodman and colleagues (2014) found that paternal responsiveness during play interactions with 2-year-olds was positively associated with children’s subsequent Executive Function (EF) scores when they were 3-5 years of age. The contribution made by paternal responsiveness to children’s EF outcomes was significantly greater than that of maternal responsiveness (Towe-Goodman et al., 2014).

The language development literature has provided evidence for the important, potentially unique, role that fathers play in their children's language development (Tamis-LeMonda et al., 2002). Pancsofar and Vernon-Feagans (2006) examined parental language with 2-year-olds and found that, compared to mothers, fathers generally produce less speech during play interactions, particularly when their partner is present. However, fathers' – and not mothers' – language quantity and quality during triadic contexts at 2 years was found to predict children's expressive language ability at 3 years. Similar results were reported by Pancsofar and Vernon-Feagans' (2010) study, in which a significant positive association between fathers' language quality and 3-year-old children's expressive language scores was identified. This association held after controlling for family demographics, mothers' education and language quality. Such findings support the view that fathers may play a unique role in the development of their children's expressive linguistic skills.

One key factor that may underlie the differences observed in maternal and paternal language quality is the differential influence that a child's age appears to have on parents' behaviour. A positive relationship has been posited to exist between mothers' vocabulary diversity and children's age (Bingham et al., 2013; Rowe et al., 2005). This association has not been reported in father samples, which suggests that fathers may provide more diverse linguistic input to younger children than mothers (Bingham et al., 2013; Rowe et al., 2005). Such parental language differences may explain the unique association that has been found between fathers' language quality and toddlers' expressive language ability (Bingham et al., 2013). In families affected by maternal depression, fathers' role in children's language development may be particularly important in buffering the adverse linguistic outcomes that have been linked to children's exposure to maternal depression.

1.5.4 Perinatal depression, coparenting and its associations with child outcomes

Family systems theory conceptualises the family unit as a complex system containing interdependent relationships (Cox & Paley, 2003). In line with this theory, the "spill-over" hypothesis (Engfer, 1988; Katz & Gottman, 1996) posits that positive or negative dynamics within any family relationship are likely to affect other relationships. For example, the emotions triggered by marital dissatisfaction tend to negatively impact not

only partner interactions but also interactions involving other family members or processes, including the parent-child and coparenting relationships (Tissot et al., 2016).

Coparenting refers to the ways in which mothers and fathers coordinate and support each other's parenting, in order to provide for their child's needs (McHale & Rasmussen, 1998; Minuchin, 1974). A positive coparenting relationship, in which parents exhibit high levels of support and low levels of undermining behaviours, is typically characterised by parents' joint investment in their child and respect for each other's parenting judgements (Schoppe-Sullivan et al., 2004). Conversely, low support and high levels of undermining behaviours, such as dismissal of each other's parenting and active competition for the child's attention, are markers of low coparenting quality (Solmeyer & Feinberg, 2011). The coparenting relationship has a more direct link to children compared to the related, yet distinct, marital relationship, and has been shown to have a greater influence on children's outcomes, compared to other family relationships (Frosch et al., 2000; Nandy et al., 2021).

While parental depression has been identified as a major factor underlying low coparenting quality (McDaniel & Teti, 2012), some researchers have argued that the relationship is bidirectional, as low coparenting quality may also predict parental depressive symptoms (Solmeyer & Feinberg, 2011). Low coparenting support may exacerbate parental perinatal depression, and – in previously non-depressed parents – may trigger depressive symptoms (Tissot et al., 2016). In contrast, and relevant to the context of the current study, depressed parents who have a positive coparenting relationship may experience alleviated symptoms as a result of their partner's support (Tissot et al., 2016).

Feinberg's (2003) ecological model of coparenting proposed that the relationship between coparenting quality and children's outcomes is mediated by parenting quality and parental adjustment, which encompasses parental self-efficacy and mental health. As mental health is a core component of parental adjustment, it is important to consider the influence that depression may have on parents' ability to engage in supportive coparenting. Depressed parents are more likely to engage in withdrawal and frequent displays of negative emotions, and such behaviours increase the likelihood of conflict and distress within the coparenting relationship (Conger et al., 2010; Williams et al., 2015).

Observational research has provided evidence for the distinct associations that coparenting may have with maternal versus paternal depression. In cross-national studies of Swiss and American coparenting, Tissot et al. (2016; 2019) reported a significant negative association between maternal depression and observed coparenting cooperation,

with no such effect observed among fathers with depression; this finding was reported in both samples. The authors suggested that previous research linking more adverse effects of family relationship issues with women's mental health, may underlie this difference between mothers and fathers (Milkie et al., 2008; Elliott et al., 2015).

Beyond observed coparenting quality, it is also important to consider the impact that depression may have on parents' perceptions of their coparenting relationship. Current research suggests that paternal depression may have a greater negative impact on fathers' perceptions of coparenting quality than maternal depression has on mothers' perceptions (Bronte-Tinkew et al., 2007; Bronte-Tinkew et al., 2009; MacDonald et al., 2020). Paternal depression is also associated with more negative perceptions of fathers' own coparenting behaviours. For example, in Elliston et al.'s (2008) study of coparenting, paternal depression was significantly associated with fathers' self-reported withdrawal during coparenting interactions.

Several studies examining the impact of one partner's depression on the other's perception of their marital relationship have provided evidence for a "cross-over" effect of one partner's depression influencing the other partner's subsequent relationship perception (e.g. Du Rocher Schudlich et al., 2011). To the author's knowledge, the only study to examine cross-over effects of depression in a coparenting relationship was conducted by Williams (2018). Paternal depression at 3 years postpartum was linked to mothers' lower coparenting perceptions at 5 years postpartum. However, maternal depression was not found to impact fathers' subsequent perceptions of their coparenting. Williams (2018) proposed that the absence of an association between maternal depression and fathers' subsequent coparenting perceptions may be explained, at least partially, by the nurturant-role hypothesis (Gove, 1984, as cited by Williams, 2018). From this perspective, mothers may continue to support their partner's parenting, even during times of personal ill-health. While further research is required to elucidate the relationships between each parents' depression levels, and differences in their perceived and observed coparenting quality, current findings suggest that depression may have a greater negative impact on fathers' supportive coparenting behaviours compared to mothers (Bronte-Tinkew et al., 2007; Elliston et al., 2008; Isacco et al., 2010), and that maternal depression, particularly at low levels, may not significantly impact fathers' perceptions of their partner's support in their parenting role (Williams, 2018).

Coparenting quality has been identified as a significant predictor of offspring outcomes, from infancy to adolescence (Feinberg et al., 2007). Low coparenting quality

during infancy and toddlerhood have been found to account for a significant proportion of emotional and cognitive deficits in children, including depressive symptoms (Katz & Low, 2004), and increased externalising symptoms in later childhood (Schoppe et al., 2001; Murphy et al., 2016). Most research that has examined associations between coparenting quality and children's outcomes has focused on psychosocial functioning. However, one study by Bingham and colleagues (2013) examined the impact of coparenting on parents' language-use during play interactions, which has been significantly associated with children's language development.

One of the coparenting dimensions that Bingham et al. (2013) examined – parental balanced involvement – was found to significantly predict the quantity and quality of fathers' language, but no associations with coparenting quality were found for mothers' language. As mothers typically produce more speech than fathers in triadic interactions, Bingham and colleagues (2013) proposed that this dimension likely represented a source of implicit maternal support for fathers. This finding suggests that mothers' engagement in supportive coparenting may have an indirect positive influence on children's language development, given the fact that fathers' language quantity and quality have been reported to uniquely contribute to children's expressive ability at 2 and 3 years of age (Pancsofar & Vernon-Feagans, 2006; 2010).

Another developmental domain that requires further examination in a coparenting context is adaptive development, which relates to children's acquisition of skills that enable them to independently navigate their environments (Bayley, 2006). The first coparenting study to examine this domain was recently conducted by Nandy and colleagues (2021). In this study, observed undermining coparenting was associated with toddlers' development of poorer social and communicative skills. Furthermore, mothers' negative perceptions of the coparenting relationship were also associated with toddlers' poorer communication, which provides evidence for the view that, aside from the previously reported adverse impact that negative coparenting perceptions can have on partners, such perceptions can also significantly impact children's outcomes.

Overall, the current literature supports the view that supportive coparenting relationships provide an important foundation for positive dynamics within the family system, which can have significant implications for both parents and their children. Several facets of coparenting require further research in the context of perinatal depression, particularly the impact of cross-over effects between parents' depression and their partner's subsequent perceptions of the coparenting relationship (Williams, 2018), as

well as further examination of the specific aspects of development that are significantly influenced by children's exposure to perinatal depression and varying levels of coparenting support.

1.5.5 Early childhood resilience

While a supportive postnatal environment plays an important role in attenuating the likelihood of children experiencing adverse effects associated with perinatal depression, it is important to consider another factor which may underlie positive developmental outcomes: resilience. Children who have been exposed to adverse environmental conditions, yet display no developmental deficits, have come to be termed as 'resilient' (Luthar et al., 2000, as cited by Giallo et al., 2018). Resilience research has studied various protective factors for high-risk children, which may effectively buffer the impact of their exposure to parental depression.

In addition to identifying protective factors, researchers have begun to examine 'resource factors', which may promote positive functioning among children in both high- and low-risk contexts (Giallo et al., 2018). Resource factors are particularly relevant to the current study, as depressed mothers' children are being reared in otherwise low-risk contexts. Lewandowski et al. (2014) conducted a 20-year longitudinal study of depressed and non-depressed parents and identified family cohesion and easier temperament as two major resource factors for children. A child with an easier temperament, characterised by high positive affectivity, will be less adversely affected by insensitive parenting, and less likely to engage in reciprocal negativity (Downey & Coyne, 1990). Furthermore, these children may develop more advanced social skills, through attempts to gain positive attention from adults other than their depressed mother ("Maternal Depression", 2004). Hence, such resource factors may also play an important role in mitigating the effects of children's exposure to perinatal depression.

1.6 Thesis Aims and Structure

The primary aim of this thesis is to examine the relationship between perinatal depression and children's developmental outcomes at 2 and 3 years postpartum. While existing research examining certain domains, particularly children's social-emotional development, seems to present relatively consistent findings – linking prolonged exposure to parental depression with generally poorer outcomes – less consensus exists with regard to children's cognitive and language outcomes. Furthermore, as far as the author is aware,

no studies have examined children's adaptive development in relation to perinatal depression. Many studies examining associations between perinatal depression and children's outcomes in the current study's age group have been cross-sectional, and most existing longitudinal studies have relied solely on parental self-report of depressive symptoms.

Furthermore, relatively few studies have investigated the potential buffering role that fathers may play for children exposed to maternal depression, as well as the impact that coparenting quality may have on the development of children exposed to perinatal depression. Hence, the current study aims to further our understanding of the relationship between perinatal depression and children's outcomes, through its longitudinal design, use of clinical interview to evaluate depression severity at each timepoint, and our inclusion of fathers at the 2-year timepoint, which enabled our examination of both parents' concurrent depression levels, alongside the quality of various observable parenting behaviours during parent-child play interactions.

This thesis will examine relationships between maternal antenatal and concurrent depression, paternal concurrent depression, and children's social-emotional, cognitive, language and adaptive development. Parents' and children's HPA axis activity will be examined, through the evaluation of maternal antenatal and concurrent levels of salivary cortisol, as well as fathers' and children's concurrent cortisol levels. Finally, we will explore the roles of parenting behaviours – parental warmth, responsiveness, child-directed speech and coparenting quality – in the relationship between children's exposure to perinatal depression and their subsequent developmental outcomes.

This chapter provided an overview of the current literature relating to perinatal depression and children's developmental outcomes. Chapter 2 will describe the methods and measures used in the study. Chapter 3 will examine associations between perinatal depression and children's developmental outcomes at 2 and 3 years. Chapter 4 will examine the relationship between parents' and children's HPA axis activity. Chapter 5 will investigate the relationship between perinatal depression, coparenting quality and children's outcomes at 2 years postpartum. Chapter 6 will examine the quality of parenting behaviours and their associations with children's developmental outcomes at 2 and 3 years postpartum. Finally, Chapter 7 – the discussion and conclusion – will review the main findings, discuss the study's strengths and limitations, and suggest future research avenues.

Chapter 2
Method

2.1 Study design and overview

The studies described in this thesis represent part of a larger prospective longitudinal study conducted by the REDEEM group (Research in Depression, Epigenetics, Endocrinology and Neuroimaging), which received funding from the Health Research Board (HRB) and National Children's Research Centre (NCRC). The first and foundational study recruited a sample of 100 women during pregnancy, who formed three groups: 1. Depressed (those with a clinical diagnosis of MDD); 2. History (currently euthymic with at least one previous MDD episode); 3. Control (no history of psychiatric disorder). The study was prospective in design and aimed to examine the relationships among perinatal depression, mothers' and infants' HPA axis activity, parent-child interaction, and children's developmental outcomes. O'Leary and colleagues (2019) reported on infants' outcomes at the earlier 2-, 6-, and 12-month timepoints.

This thesis focuses on data collected at the study's fifth and sixth timepoints – 2 and 3 years postpartum – wherein a structured observational design was used to capture naturalistic parent-child play interactions. The observational methods employed in the Trinity College Infant and Child Research Lab facilitated the macro- and micro-examination of parent-child interaction quality. While the primary focus of this research lies in assessing the impact of maternal perinatal depression on children's outcomes, the study's scope was broadened at the 2- and 3-year timepoints to include fathers, with the aim of considering the impact that paternal concurrent depression levels and fathers' interactional play behaviours may have on children's early development. The rationale of the current study was to examine the impact of perinatal depression on offspring outcomes over a longer period than is typical of research in this area. Through its longitudinal design, and inclusion of fathers at the final timepoints, this study aimed to expand our understanding of perinatal depression as it relates to both mother- and father-child interaction quality and children's developmental outcomes.

2.1.1 Author's contribution of work

I was primarily responsible for data collection and analysis at the 2- and 3-year timepoints. I scheduled follow-up appointments at the TCD Infant and Child Research Laboratory. During these appointments, I carried out parents' interviews and children's developmental assessments, collected questionnaire data, video- and audio-recorded parent-child interactions, and transcribed the content of recordings, at each of these timepoints. When I started my PhD, 2-year data collection was underway, the first phase

of which had been carried out by Dr. Niamh O’Leary, who had completed data collection at the previous 2-, 6- and 12-month timepoints. I was assisted in running the remaining 2- and 3-year follow-up appointments by then PhD candidates at the Infant and Child Research Laboratory: Dr. Linda Kelly, Dr. Angana Nandy, Desiree Grafton-Clarke, Merve Ataman and Chelo del Rosario. A final year Psychology student, Jean Sinnott assisted in the 3-year follow-ups, by acting as the stranger in a modified version of Ainsworth et al.’s (1978) ‘Strange Situation’. Dr. Angana Nandy rated the coparenting quality displayed by parents, and a research assistant in the lab, Maeve McAuliffe, completed the parental warmth ratings.

2.1.2 Ethical Considerations

The study received ethical approval from the research ethics committees in the three participating maternity hospitals: the National Maternity Hospital (NMH), Holles Street, Dublin 2; the Coombe Women and Infants’ University Hospital (CWIUH), Cork Street, Dublin 8, and the Rotunda Hospital (RH), Parnell Street, Dublin 1. This study complies with the Declaration of Helsinki, and approval was granted by the School of Psychology Research Ethics Committee, in Trinity College Dublin, prior to data collection. Written parental consent was provided by all participating families.

2.2 Participants

Participants were recruited from perinatal Psychiatry services and antenatal booking clinics, and were assessed by Dr. Chaitra Jairaj, a research registrar in Psychiatry, who stratified participants into one of three groups:

- (i) Depressed: Currently diagnosed with Major Depressive Disorder (MDD), according to DSM-IV-TR criteria.
- (ii) History of Depression: Currently euthymic, with a history of at least one previous episode of MDD.
- (iii) Control: Euthymic, with no history of MDD or any other psychiatric disorder.

At the study’s baseline, there were 23 women in the Depressed group, 34 in the History group, and 43 in the Control group.

The DSM-V saw the replacement of postpartum depression with perinatal depression, which included individuals who had major depressive disorder (MDD) during pregnancy,

as well as individuals who experienced MDD up to four weeks postpartum. It is important to note that the core diagnostic criteria for MDD did not change from DSM-IV-TR to DSM-V and that the current study included a group of women who had MDD during pregnancy. Hence, while the DSM-IV-TR MDD diagnostic criteria guided Dr Jairaj's participant stratification, the overall study was in line with DSM-V diagnostic criteria, as the DSM-IV-TR did not include MDD during pregnancy as a distinct disorder that could occur outside of postpartum depression.

2.2.1 Inclusion and Exclusion Criteria

Women who wished to participate in the study were included if they were in their second or third trimester of a singleton pregnancy, were fluent in English, and met no exclusion criteria. Chronic health conditions, a history or current diagnosis of an anxiety, psychotic, personality or substance abuse disorder, long-term medication-use – aside from an antidepressant or mood stabiliser – and obstetric complications all constituted exclusion criteria for participation in this study. The flow of participants is shown in Figure 2.1.

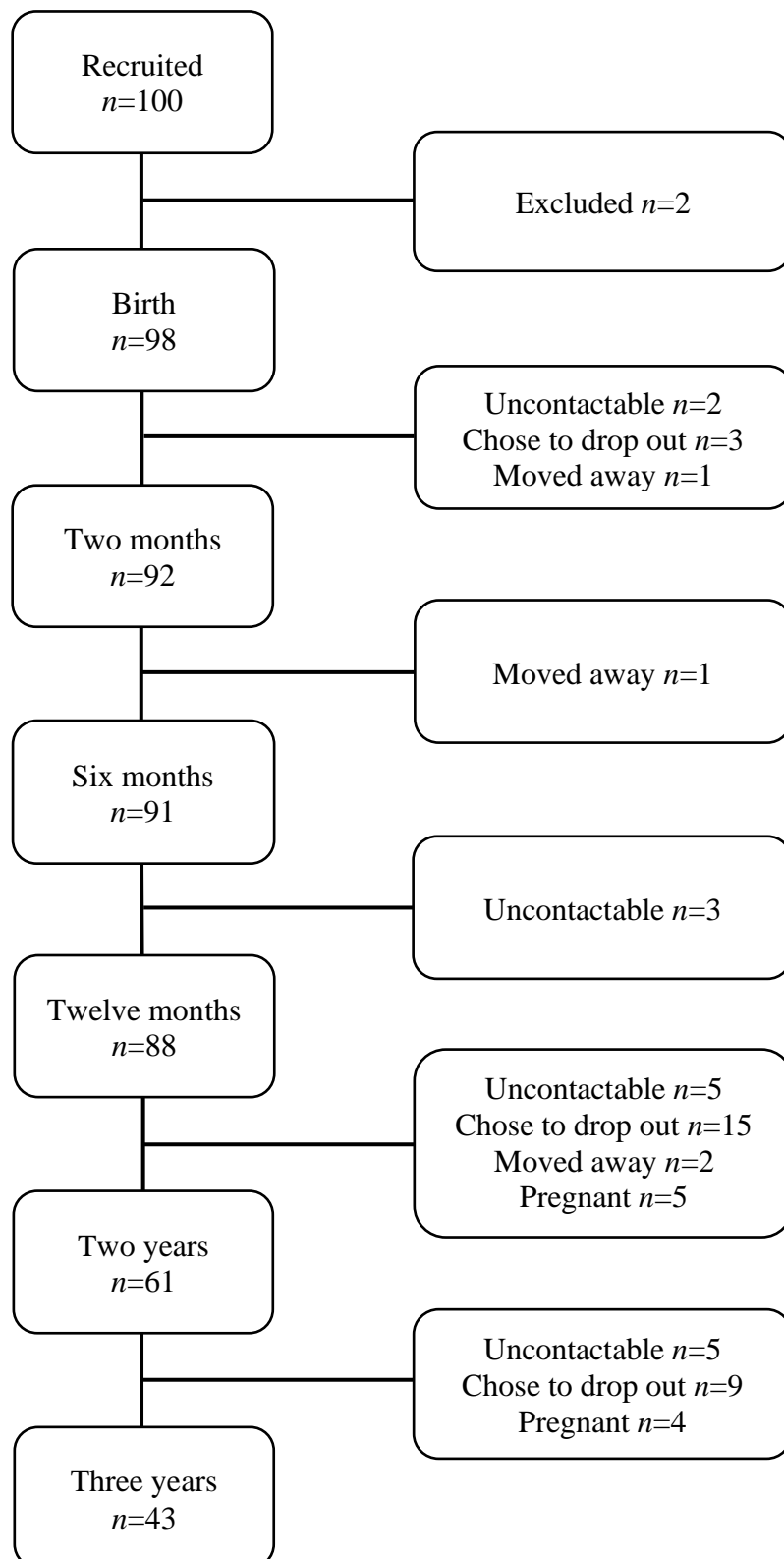


Figure 2.1. Flow chart of the study's sample.

2.2.2 Parental Characteristics

Sixty-one mothers and their children (M age=26 months, $SD=1.83$; 35 boys and 26 girls) remained in the study at 2 years, with 11 Depressed participants, 21 with a History of Depression, and 29 control participants, equating to an overall attrition rate of 39.79%. Demographic information regarding mothers' age, ethnicity, education, employment and relationship status was obtained at the study's baseline timepoint, while participating fathers provided their demographic information at the 2-year timepoint. The demographic characteristics of mothers who participated in the 2-year follow-up are displayed in Table 2.1. Mothers ranged in age from 28 to 50 years ($M=36$, $SD=4.64$), while fathers' ages ranged from 25 to 51 years ($M=38$, $SD=5.22$). 93% of mothers had completed third-level education, 92% were married or cohabiting, and 85% were employed. Of the 41 fathers who participated in the 2-year follow-up, 81% had completed third-level education, and 100% were employed.

A series of Fisher's Exact tests were conducted to examine group differences in demographic characteristics at 2 and 3 years, and the results indicated that there were no significant group differences for maternal ethnicity, education, or relationship status. However, at 2 years there was a significant difference between the Control and History of Depression groups for maternal employment, (Fisher Exact Test, $p=.012$). To interpret the Fisher's Exact result, standardised residuals were examined. The standardised residual was less than 2, which indicated that the observed frequency of employment was lower than the expected frequency for participants in the History of Depression group.”

Table 2.1*Demographic characteristics of mothers who participated at the baseline timepoint, and at 2 and 3 years postpartum.*

	Baseline			2 years			3 years		
	Depressed (n=23)	History (n=34)	Control (n=43)	Depressed (n=11)	History (n=21)	Control (n=29)	Depressed (n=5)	History (n=17)	Control (n=20)
Age (M, SD)	31.61 (3.88)	32.44 (5.24)	33.91 (4.73)	33.64 (3.85)	35.50 (5.37)	36.67 (4.22)	33.2 (4.21)	38.47 (3.21)	38.2 (4.27)
Ethnicity (n, %)									
Irish	17 (73.9%)	22 (64.7%)	29 (67.5%)	11 (100%)	18 (85.7%)	26 (89.7%)	5 (100%)	13 (76.5%)	16 (80%)
Non-Irish White	5 (21.8%)	8 (23.5%)	9 (20.9%)	-	1 (4.8%)	2 (6.9%)	-	3 (17.6%)	2 (10%)
African	1 (4.3%)	2 (5.9%)	1 (2.3%)	-	-	1 (3.4%)	-	-	1 (5%)
Hispanic	-	2 (5.9%)	1 (2.3%)	-	2 (9.5%)	-	-	1 (5.9%)	1 (5%)
South Asian	-	-	3 (7%)	-	-	-	-	-	-
Education (n, %)									
Lower secondary	1 (4.3%)	3 (8.8%)	1 (2.3%)	-	-	1 (3.4%)	-	-	1 (5%)
Higher secondary	2 (8.7%)	4 (11.8%)	1 (2.3%)	1 (9.1%)	2 (9.5%)	-	-	-	-
Third level degree (non-honours)	4 (17.4%)	4 (11.8%)	7 (16.3%)	3 (27.3%)	2 (9.5%)	4 (13.8%)	1 (20%)	2 (11.7%)	1 (5%)
Third level degree (honours)	10 (65.2%)	13 (38.2%)	19 (44.2%)	3 (27.3%)	9 (42.9%)	13 (44.8%)	3 (60%)	7 (41.2%)	9 (45%)
Masters degree	5 (21.7%)	8 (23.6%)	13 (30.2%)	4 (36.3%)	7 (33.3%)	9 (31.1%)	1 (20%)	7 (41.2%)	7 (35%)
Doctorate	-	1 (2.9%)	2 (4.7%)	-	1 (4.8%)	2 (6.9%)	-	1 (5.9%)	2 (10%)
Other/ not stated	1 (4.3%)	1 (2.9%)	-	-	-	-	-	-	-
Relationship status (n, %)									
Single	2 (8.7%)	2 (5.9%)	3 (7%)	1 (9.1%)	2 (9.5%)	2 (6.9%)	1 (20%)	1 (5.9%)	1 (5%)
Cohabiting	10 (43.5%)	8 (23.5%)	12 (27.9%)	6 (54.5%)	3 (14.3%)	7 (24.1%)	-	4 (23.5%)	2 (10%)
Married	11 (47.8%)	24 (70.6%)	28 (65.1%)	4 (36.4%)	16 (76.2%)	20 (69%)	4 (80%)	12 (70.6%)	17 (85%)
Employed (n, %)	18 (78.3%)	21 (61.8%) ^a	40 (93%)	9 (81.8%)	15 (71.4%) ^a	28 (96.6%)	4 (80%)	15 (88.2%)	19 (95%)

^a Significant difference with the Control group.

2.2.3 Participant Recruitment

Baseline recruitment

The majority of recruitment for the Depressed and History participant groups took place through the NMH's and CWIUH's Perinatal Psychiatry services, by Dr. Jairaj. Women who were interested in participating, and met the inclusion criteria, were given an information leaflet, which provided details regarding the study and what participation would entail. Participants in the Control group were recruited in a similar manner, from the participating hospitals' antenatal clinics by Dr. Jairaj and Dr. O'Leary. Women who expressed a desire to participate provided their contact details and were subsequently contacted by email or phone. Written consent was provided by all participants prior to beginning the study.

2- and 3-year recruitment

An introductory email explaining the author's takeover from the previous PhD researcher was sent to all potential follow-up participants. Mothers' interest and availability to participate in 2- and 3-year follow-ups were gauged through subsequent emails and phone calls. The study sought to also include fathers in these follow-up appointments. Mothers who expressed interest in taking part were asked to enquire as to whether the child's father would also be interested and available to participate and were informed that they would receive another call later that week to ascertain whether both parents would be attending. All 2- and 3-year follow-ups took place in the Infant and Child Research Laboratory, Trinity College Dublin. To facilitate working parents, the majority of lab appointments took place on weekend mornings. Participants who were available to attend were offered a compensatory payment of 30 euro towards travel expenses.

2.2.4 Follow-up procedure

Approximately two weeks prior to the scheduled lab appointment, information packs were posted to participants. All packs contained a letter with the details of their appointment, an information sheet, a map of the college campus with the lab's location highlighted, and a saliva swab kit for parents to complete prior to their follow-up appointment. Fathers who were not available to attend the follow-up but expressed a desire to participate in the research were sent mood- and parenting-related questionnaires, which would have been completed during the follow-up, and a saliva swab kit, which the mothers were asked to bring along with theirs on the day of the lab appointment. Each

appointment involved participants' engagement in parent-child play interactions, a developmental assessment of the child, child saliva sampling, and a parental Hamilton Depression Scale (HAM-D)-based interview.

At the beginning of the appointment, participants were guided through the information sheet (Appendix A) and given the opportunity to ask questions about the study. Following this, participants signed a consent form (Appendix B). After the child had familiarised themselves with the laboratory room, their first saliva sample was obtained, which served as a baseline cortisol measure, to compare to two samples taken later in the appointment – one prior to the child's exposure to a stressor, and the other 30 minutes later. Details regarding this aspect of the study are provided in Section 2.3.5. The child's first swab was followed by triadic play interactions. The developmental assessment was then commenced, during which time the mother sat beside the child. The assessment was typically paused half-way through the tasks, to give the child a break. The mother-child play interactions then took place, while the father was interviewed and given questionnaires to complete in a nearby office. The remainder of the developmental assessment was carried out after the father had returned to the lab room, and was followed by father-child play interactions, which took place while the mother completed her interview and questionnaires in the office. The 2-year follow-up appointment lasted approximately 2.5-3 hours, while the 3-year follow-up was approximately 2 hours in length.

2.3 Measures

The clinical and behavioural measures that were used with participants are summarised in Table 2.2.

Table 2.2*Measures used at each study timepoint.*

Participant	Measure	Pregnancy	2 months	6 months	12 months	2 years	3 years
Mother	Clinical interview	MINI, HAM-D	HAM-D	HAM-D	HAM-D	HAM-D	HAM-D
	Clinical questionnaires	CES-D, PSS, PSQI, CTQ	CES-D, PSS, PSQI	CES-D, PSS, PSQI	CES-D, PSS, PSQI	CES-D, PSS, PSQI	CES-D, PSS, PSQI
Father	Clinical interview	-	-	-	-	HAM-D	HAM-D
	Clinical questionnaires	-	-	-	-	CES-D, PSS, PSQI, CTQ	CES-D, PSS, PSQI
Child	Development	-	NBAS	NBAS	BSID	BSID Cognitive & Language	BSID Language, EF
	Parent-child interaction quality	-	Dyadic MC interaction	Dyadic MC interaction	Dyadic MC interaction	Dyadic MC & FC interactions; triadic interactions	Dyadic MC & FC interactions; triadic interactions

Note. MINI = Mini International Neuropsychiatric Interview; HAM-D = Hamilton Depression Rating Scale; CES-D = Center for Epidemiologic Studies - Depression Scale; PSS = Perceived Stress Scale; PSQI = Pittsburgh Sleep Quality Index; NBAS = Neonatal Behavioural Assessment Scale; BSID = Bayley Scales of Infant Development; EF = Executive Function; MC = mother-child; FC = father-child.

2.3.1 Parental Clinical Measures

Hamilton Rating Scale for Depression (HAM-D; Hamilton, 1960)

The HAM-D (Appendix C) is a clinician-rated measure for depression severity comprising 21 items. Scoring is based on the first 17 items, which assess the severity of depressive symptoms, such as low mood and feelings of guilt. The four additional items relate to less typical depressive symptoms, including obsessional and compulsive behaviours. Internal consistency for the HAM-D is good, at .83 (Rush et al., 2003). Scoring based on 17 items has a maximum possible score of 52. The HAM-D is considered the gold standard assessment of MDD, demonstrating stability over time (Kim et al., 2014). However, it is less commonly used than other measures of depression severity as it is more complicated and takes longer to administer than self-report questionnaires (Gerbasi et al., 2020). It was used in the current study, alongside the CES-D and PSS, to obtain rich data on parents' mood. The HAM-D scores associated with each level of depression severity are shown in Table 2.3.

Table 2.3

Depression severity categories based on HAM-D scores.

Depression Severity	HAM-D Score
Normal	0-7
Mild	8-13
Moderate	14-18
Severe	19-22
Very severe	≥ 23

Center for Epidemiologic Studies - Depression Scale (CES-D; Radloff, 1977)

The CES-D (Appendix D) is a 20-item self-report measure, which evaluates an individual's current symptoms of depression. Respondents are asked to report the frequency with which each item applied to them during the past week by selecting one option from a Likert scale, ranging from (i) rarely or none of the time (less than 1 day), to (iv) most or all of the time (5-7 days). Each item is scored on a scale of 0-3 points, and four of the 20 items are reverse-scored. The highest possible score is 60. Although the CES-D is not a clinical measure of depression, the suggested cut-off score of ≥ 16 was validated by a meta-analysis that reported sensitivity of 0.87 and specificity of 0.70 in its

ability to detect depression within the general population (Vilagut et al., 2016). Internal consistency ($\alpha=.90$) for the CES-D is excellent (Cosco et al., 2017), while test-retest reliability for individual items ranges from poor to very good (ICC=0.11-0.73; LaChapelle & Alfano, 2005; Miller et al., 2008). Internal consistency (Cronbach's alphas) for the current study were .74 for mothers and .68 for fathers.

Perceived Stress Scale (PSS; Cohen et al., 1983)

The PSS (Appendix E) is a self-report questionnaire, comprising 14 items, designed to evaluate the extent to which various aspects of everyday life are perceived as stressful. Participants are asked to indicate how often they experienced a given feeling or thought in the past month. A five-point scale is provided for each item, ranging from (i) never to (v) very often. Each item produces a score from 0-4, and 6 of the items are reverse-scored. Reported internal consistency for the PSS-14 ranges between .81 (Remor, 2006) and .85 (Leung et al., 2010). Test-retest reliability is also very good, ranging from ICC=.73-.90 (Remor, 2006; Almadi et al., 2012). Internal consistency (Cronbach's alphas) for the current study were .72 for mothers and .69 for fathers.

Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989).

The PSQI (Appendix F) is a self-report measure used to evaluate an individual's sleep patterns and quality. Seven aspects of sleep quality, experienced during the past month, are examined: sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, daytime dysfunction, and subjective sleep quality. Scores from each area are summed to obtain a global score for sleep quality that can range from 0 to 21. A global score of 5 or more indicates poor sleep quality. The PSQI has exhibited acceptable internal consistency with α values ranging from 0.77 to 0.83 (Carpenter & Andrykowski, 1998; Doi et al., 2000). The PSQI has also shown good test-retest reliability (ICC=.85-.87; Buysse et al., 1989; Backhaus et al., 2002). Internal consistency (Cronbach's alphas) for the current study ranged from .52 to .64.

Childhood Trauma Questionnaire- Short Form (CTQ-SF; Bernstein et al., 2003)

The Childhood Trauma Questionnaire (CTQ; Appendix G) is a self-report assessment that measures an individual's exposure to five types of childhood trauma: emotional, physical, and sexual abuse, and emotional and physical neglect. The original CTQ comprises 78 items, while the shortened version contains 28. There are 25 clinical items, with each type

of trauma represented by five items, and three minimisation/ denial items that evaluate respondents' tendency to minimise their experience of trauma. Participants are asked to indicate their agreement with a given statement, with each item's response options ranging from 1 'never true' to 5 'very often true'. Studies have reported good internal consistency ($\alpha > .80$) for all CTQ-SF's scales, except for the physical neglect scale, which has been reported to have alpha values ranging from .53 to .70 (Bernstein et al., 2003; Karos et al., 2014; Thombs et al., 2009). The CTQ-SF has demonstrated very good test-retest reliability (Spearman's $\rho = 0.75$, and Pearson's $r = 0.87$; Kim et al., 2011; Kim et al., 2013). In the current study, internal consistency (Cronbach's alpha) for the CTQ-SF scales ranged from poor ($\alpha = .42$ for the physical neglect scale to good ($\alpha = .78$) for the emotional abuse scale.

2.3.2 Child measures

Bayley Scales of Infant Development-3rd Edition (BSID-III; Bayley, 2006)

The BSID-III scales are a widely used measure of infant and toddler developmental functioning. The BSID-III can be used with children from 1 to 42 months of age, and comprises scales designed to assess three domains – cognitive, language and motor development. In the current study, the cognitive and language scales were administered at the 2-year follow-up, while only the language scales were administered at the 3-year follow-up, as children's Executive Function ability was also assessed at this timepoint. Children's raw scores are converted to norm-referenced scale scores, and composite scores, which are then scaled to a metric range from 40 to 160 ($M = 100$, $SD = 15$). The language scale comprises two subscales: receptive and expressive, which can be assessed separately to examine each aspect of children's language development, and also summed to produce an overall language composite score. Both the Cognitive ($\alpha = .91$) and Language ($\alpha = .93$) composite scores have demonstrated excellent reliability (Albers & Grieve, 2007).

Bayley-III Social-Emotional Scale (Greenspan, 2004)

The BSID-III Social-Emotional (SE) Scale comprises a 35-item questionnaire, typically completed by mothers, which was developed using the Greenspan Social-Emotional Growth Chart (Greenspan, 2004). This scale evaluates a child's developing social-emotional skills, such as self-regulation, prosocial engagement and communication of needs. The scores given for each item are tallied to produce a raw SE score. The raw

score is converted to an age-dependent scale score, which yields a composite SE score. Internal consistency for the scale has been found to range from $\alpha=.83-.94$ (Albers & Grieve, 2007).

Bayley-III Adaptive Behaviour Scales (Harrison & Oakland, 2003)

The Adaptive Behaviour Scale is a 241-item questionnaire, designed to assess a child's daily functional skills. The questionnaire is based on the Parent/Primary Caregiver Form (for ages 0–5 years) of the Adaptive Behaviour Assessment System-Second Edition (Harrison & Oakland, 2003). The Adaptive Behaviour Scale is typically completed by the child's mother and comprises three subscales: Conceptual, Practical, and Social Adaptive Behaviour. Items assess ten different skill categories: communication, community use, functional pre-academics, home living, health and safety, leisure, self-care, self-direction, social and motor. The score for each of these scales is summed and converted to a General Adaptive Composite score. Average reliability coefficients across each of the skill areas, adaptive domains, and the General Adaptive Composite (GAC) have been found to range from $\alpha=.79-.98$ (Albers & Grieve, 2007).

Executive Function

Five tasks from a battery designed by Willoughby and colleagues (2010) and adapted for use in the Infant and Child Research Laboratory (Kelly, 2016), were used to assess children's Executive Function (EF) ability at the 3-year follow-up. The criterion and predictive validity, as well as the test-retest reliability of the battery has been verified by formal psychometric evaluations based on 3-year-old participants (Willoughby et al., 2010; Willoughby & Blair, 2011). A script was followed when administering the tests, and the number of correct responses was summed to produce a child's overall EF composite score, with a maximum possible score of 44. The tasks used were designed to evaluate the core components of children's EF development - working memory, attention-switching, and inhibitory control of prepotent and motor responses. Each task is outlined below.

Working memory task

The child was shown a card depicting the outline of a house with an animal (dog, cat, rabbit or pig) and a coloured dot (red, yellow, blue or green) above the animal. The child was asked to name the animal and the colour of the dot. The card was then removed and

the child was presented with a new card, showing only the outline of the house. The child was then asked to name the animal that had been inside the house. This task was designed to test children's working memory as it required holding two distinct objects in mind, and naming only one, while the coloured dot interfered with their memory retrieval. Six different one-house trials were run, followed by four two-house trials, which depicted two different animals and two different coloured dots.

Spatial conflict task

The child was presented with a response card, which had a picture of a bucket on the left-hand side and a ball on the right. The child was asked to touch the bucket on their response card every time the research assistant (RA) held up a picture of the bucket, and to touch the ball every time the RA held up a picture of the ball. The first six trials involved the presentation of cards with the bucket or ball depicted in the centre of each card, while the following six trials involved the presentation of cards with lateral depictions of the bucket or ball, which matched the lateral side that the items were depicted on the child's response card. These trials were designed to establish an automatic motor response to the presentation of each picture, based on their spatial location on the response card. Then, for the final six trials, the RA's cards depicted the bucket or ball laterally once and contra-laterally twice. In the four contralateral trials the pictures were displayed on the opposite side to where they were located on the child's response card. This task was designed to evaluate children's inhibitory control, as successful completion required inhibition of their responses to trials in which the stimuli's spatial location differed to the response card.

'Something's the same' task

The child was introduced to this task with four practice rounds, in which stimuli were framed in terms of their similarity in one of three dimensions (shape, size or colour). The RA presented two cards depicting objects that shared one dimension and stated "These two pictures are the same. They are both stars/big/yellow". After completing the practice rounds, the child was presented with two cards and told which dimension they shared. Then, a third card was shown to the child and the RA asked them to select the card that matched one of the first two, in size, shape or colour. Nine trials were run, so that the child's ability to discern each dimension was evaluated three times. This task evaluates

children's ability to engage in attention-switching, as each trial involves a shift in attention from one dimension to another.

Silly sounds stroop

The RA presented a card depicting a cow and asked the child to name the animal and the sound that it makes. The RA repeated this with a duck card. Then, the child was told they were going to play a silly game; whenever the RA pointed to the picture of the cow, the child should "quack" and whenever they pointed to the duck picture, the child should "moo". This task comprised nine trials and was designed to evaluate children's inhibitory control of a prepotent response.

The Animal Go/No Go task

An iPad with a buzzer app that displayed a large red button that made a loud buzzing noise when pressed was presented to the child. They were then shown a set of cards depicting different animals. The child was asked to press the buzzer on the screen every time the RA presented a card that depicted any animal (cow, sheep, duck, cat, dog and rabbit) except a pig. A practice round involving the presentation of each animal card followed by the pig was run to ensure the child understood the rules of the game. The task comprised varying patterns of go no-go trials. Hence, the child was required to inhibit their motor response to one intermittent stimulus.

2.3.3 Biological Measures

Parental salivary cortisol

Saliva kits containing Sarstedt Salivette swabs were included in the information packs posted to participants prior to their lab appointment. Mothers completed saliva samples at every study timepoint, and available fathers did so at 2- and 3-years. Participants were asked to complete their saliva collection at three timepoints across one day: at 0 minutes (upon waking), 30 minutes, and 60 minutes after waking. Written instructions were provided to all participants regarding how to correctly use the swabs (Appendix H). Participants were advised to carry out their saliva sampling one day prior to their scheduled appointment. Participants who were unable to complete sampling prior to their appointment were provided with a stamped envelope and asked to return their samples to the researcher's work address at their earliest convenience.

Child salivary cortisol

Three saliva samples were obtained from children during their lab appointment, using the Salimetrics SalivaBio Children's Swabs. The first sample was obtained within 15 minutes of the family arriving and adjusting to the lab environment, the second was obtained prior to the child's exposure to a stressor, and the third was taken 30 minutes post-stressor.

2-year stressor protocol

At the 2-year timepoint, a stressful situation was orchestrated by presenting a challenging toy, designed for use by older toddlers, to the child while their mother and the researcher remained in the room, but did not interact with them. The toy was a wooden board with six locked doors to be opened, each lock varying in difficulty (Appendix I). The board was taken from the Infant and Child Laboratory's mastery task protocol for 2-year-olds. This toy was selected for use in the lab's protocol based on Morgan et al.'s (1992) 'Individualised assessment for mastery motivation' guidelines, which recommend using goal-oriented toys that are challenging for a child's developmental level. As the locks board is intended for use in children aged 3 and over, it was a suitably challenging choice of toy for 2-year-olds.

The board was placed on the mat in the laboratory, and the researcher modelled the opening of a lock, saying "look what I can do, now you try." A 3-minute timer was started once the child had attended to the board. The researcher sat on the other side of the room and did not interact with the child or mother. The mother sat at a table and was asked not to interact with the child, even if they asked for help with the board, and to maintain a 'poker face'. This aspect of the stressor was adapted from the Toddler Still-Face (T S-F) paradigm (Weinberg et al., 2008), which was designed to evaluate young children's ability to self-regulate when faced with a stressor. The T S-F comprises three 2-3-minute episodes: 1. normal mother-child play; 2. the mother's engagement in unresponsive still-face while the child attempts to continue play as normal; and 3. the reunion, wherein normal mother-child play is resumed (Weinberg et al., 2008). In the current study, the stressful situation similarly succeeded normal play between mother and child and was followed by mother-child play. Prior to initiating the stressor, the researcher explained to mothers that the task was intended to be frustrating, and that they would be able to assist their child in completing the board after the 3 minutes had ended. No child succeeded in opening more than four of the six locks on the board during the timed episode.

3-year stressor protocol

A modified version of the Strange Situation (Ainsworth et al., 1978) was used to elicit stress in 3-year-olds. The traditional Strange Situation protocol comprises eight episodes, typically lasting 15-25 minutes. In the current study, the protocol was condensed to three phases. First, mother and child engaged in a free play interaction for 10 minutes. Then, the mother left the room and a research assistant (the stranger), who the child had not met before, entered and sat down on the mat. The toys from the mother-child free play interaction were still present, and the stranger attempted to initiate play with the child. Meanwhile, the mother watched the encounter from the observation room with the researcher. The child-stranger interaction lasted 3 minutes, and like the traditional Strange Situation protocol, was followed by a reunion with the child's mother.

Salivary cortisol analysis

All saliva samples were centrifuged at 3500 rpm at 20°C for 15 minutes. 500µL samples were pipetted into microtubes, which were stored in a -80°C freezer in the Trinity College Institute of Neuroscience, until they were sent in batch on dry ice to Dr. Gerard Boran's laboratory at Tallaght University Hospital, Dublin for analysis. Salivary cortisol concentrations were measured using the Elecsys® Cortisol II immunoassay (Roche Diagnostics, 2020).

The indices used to examine parents' cortisol levels were:

- (i) Baseline cortisol, measured by averaging the three cortisol values obtained from parents.
- (ii) Area under the curve with respect to increase (AUC_i), a variable that uses the area under the curve to assess changes in cortisol output from baseline through to later time points.

Parental AUC_i served as an indicator of the cortisol awakening response (CAR).

Children's basal cortisol was indicated by the cortisol concentration measured from their first saliva sample upon arrival to the Infant and Child Laboratory. Their stress reactivity was measured using AUC_i, as well as the Area under the curve with respect to ground (AUC_g). AUC_g takes into account the distance from zero and represents the total area under the curve for all cortisol measurements (baseline, pre- and post-stressor). AUC_g reflects the difference between each measurement from each other, as well as the

intensity, as indicated by their distance from the ground (Fekedulegn et al., 2007). AUCi and AUCg were calculated using formulae provided by Fekedulegn and colleagues (2007).

2.3.4 Parent-child interaction

Video recordings

At the 2-year timepoint, two types of play interaction were observed and recorded: structured and free play. Dyadic mother-child, father-child, and triadic mother-father-child interactions were observed in both structured and free play contexts. Each structured play interaction was recorded for 5 minutes, in which time parents and children played with a wooden jigsaw. A wooden fishing board was provided for mother-child structured play, a cars board for father-child play, and a teddy bear board for triadic mother-father-child structured play. Each free play interaction was recorded for 10 minutes, and a box containing a variety of toys, including a soft ball, blocks and a Mr Potato Head, was provided for all dyadic and triadic interactions. At the 3-year timepoint, the protocol was condensed, so that only 10-minute free play interactions were observed and recorded. The same toy box that was used for 2-year free play was used for dyadic interactions, while a box containing jungle-themed Lego Duplo® blocks was provided for triadic interactions.

Two Axis Q6035 PTZ Dome Network cameras, with 1080pixel resolution, 30 fps frame rate and 20x optical zoom, mounted to two walls of the Infant and Child Laboratory, were used to record the play interactions. A BeyerDynamic MPC 66 V 12-84V microphone was connected to a XENYX 802 audio mixer, and concealed in the corner of the laboratory, to capture high-quality audio recordings of the interactions. Mangold VideoSync Pro 1.5 was used to store the video files to a hard-drive in the adjacent observation room.

Parental warmth

The Parenting Interactions with Children: Checklist of Observations Linked to Outcomes (PICCOLO) scale (Roggman et al., 2013) is an observational macro measure of parenting quality (Appendix J). The PICCOLO comprises a 29-item checklist of parenting behaviours, which were identified as developmentally supportive (Roggman et al., 2013). The checklist is intended for use by practitioners who work with children in the 10–47-month age bracket. The PICCOLO contains four subscales: affection, responsiveness, encouragement, and teaching. The current study used the affection subscale only, to

derive a measure for parental warmth, as this scale was designed to evaluate the level of warmth, physical closeness and positive affirmations displayed by parents towards their children. The affection subscale contains 7 checklist items, including “speaks in a warm tone of voice” and “shows emotional warmth”. The checklist contains a set of observation guidelines for each item, to facilitate more accurate rating. Each item is marked 0 (behaviour was absent), 1 (brief or minor example of behaviour occurred) or 2 (behaviour occurred clearly and/or frequently). The PICCOLO affection scale has shown good interrater reliability ($r = .80$; Roggman et al., 2013). The affection scale was completed by a research assistant, blind to the purpose of the study.

Parental vocal responsiveness

The dyadic free play interaction videos recorded at the 2- and 3-year timepoints were coded for child and parent vocalisations, using four software programmes: a component of the TalkBank language component – Child Language Data Exchange System (CHILDES) – known as Computerised Language Analysis (CLAN; MacWhinney, 2000), EUDICO Linguistic Annotator, version 6.1 (ELAN, 2021), Python, version 3.9, and General Sequential Querier, version 5 (GSEQ-5; Bakeman & Quera, 2011). All speech within interaction was transcribed using CLAN. Sound bullets, marking the exact location of each transcribed vocalisation within the audio file, were added to all transcripts, using the ‘sonic mode’ function within CLAN. Non-vocal sounds, such as kisses, were not coded. Then, each audio-linked transcript was exported to ELAN. ‘Annotation mode’ was used to obtain the offset and onset times in seconds and milliseconds for each parent and child vocalisation. These time data were extracted from ELAN for each recording and exported as .txt files. Python, version 3.9 was then used to convert the timestamps to a format compatible with GSEQ-5. The child offset and subsequent parent onset times were analysed, to calculate the time taken for parents to vocally respond to their child’s previous vocalisation. The ‘window’ function in GSEQ-5 was used to set a 3-second window of opportunity. Hence, all parental vocalisations that occurred within 3 seconds of the child’s previous vocal offset were categorised as responsive.

Parents’ and children’s language

Parents’ and children’s language were analysed using Child Language Data Exchange System (CHILDES) software (MacWhinney, 2000). All vocalisations made during dyadic and triadic parent-child interactions were transcribed using a component of CHILDES,

Computerised Language Analysis (CLAN). CLAN's CHECK and MOR utilities were used to confirm that all words had been transcribed in the correct morphological structure required for analysis. Parents' language was then coded for total utterances; mean length of utterance (MLU) in words; vocabulary diversity (VOCD); and mean length of turn (MLT). The KIDEVAL utility in CLAN was used to analyse children's speech for total utterances and the number of word types used. Total utterances served as a measure of language quantity, MLU in words served as an indicator of the complexity of language, and VOCD, and the number of word types, measured the diversity of vocabulary produced by parents and children respectively. Child-mother and child-father MLT measured the mean length of turn taken by children when talking to their mother, and father, respectively. Child-parent MLT ratios were then computed to serve as indicators of the conversational balance between speech partners, in both dyadic contexts.

Coparenting quality

The quality of coparenting behaviours, displayed during triadic free play interactions, was rated using scales developed by Cowan and Cowan (1996), and adapted by Schoppe-Sullivan and colleagues (2004; see Appendix K). These scales have received extensive validation in a range of cross-sectional and longitudinal studies of parent-child interaction (Buckley et al., 2010). Coparenting quality ratings were based on eight dimensions: four measuring supportive coparenting (pleasure, warmth, cooperation and interactiveness), and four measuring undermining coparenting (displeasure, coldness, anger and competition).

These dimensions were rated on a 5-point scale (1=very low; 5=very high). Based on support from previous research, the coding data were subsequently condensed into two composite variables – supportive coparenting and undermining coparenting (Schoppe-Sullivan et al., 2009). The supportive coparenting composite score was obtained by averaging the ratings given for pleasure, warmth, cooperation and interactiveness, while the undermining coparenting composite score was the result of averaging the ratings given for displeasure, coldness, anger and competition.

Inter-rater reliability

Coparenting quality was rated by Dr. Angana Nandy, a former PhD student in the lab who had received training from Sarah Schoppe-Sullivan on using her rating scale and completed her PhD on coparenting. Dr. Nandy was blind to the previous or current

depression status of participants. Parental warmth was rated by a research assistant blind to the nature of the study. 20% of the clips were also rated by the author. Average intraclass correlation coefficients were used to calculate the inter-rater reliability for these parenting variables, which are displayed in Table 2.4. All coefficients were greater than 0.75, indicating a good level of inter-rater reliability (Koo & Li, 2016).

Table 2.4

Inter-rater reliability coefficients.

Study timepoint	Maternal warmth	Paternal warmth	Supportive coparenting	Undermining coparenting
2 years	0.87	0.79	0.76	0.87
3 years	0.92	0.78	-	-

The inter-rater reliability for parental vocal responsiveness was calculated by comparing the vocalisation onset and offset time-related data derived from the author's audio-linked transcripts to a trained research assistant's data, which was obtained by re-audio-linking 20% of the total dyadic free play transcripts, selected at random. Cohen's time-unit kappa statistics were computed using GSEQ-5. Inter-rater reliability for mothers' and fathers' 2-year vocal responsiveness was 0.74 and 0.81 respectively. At 3 years, the kappa statistics for mothers' and fathers' vocal responsiveness were 0.79 and 0.83 respectively. There was 95% inter-rater agreement regarding what constituted a vocalisation, as opposed to a non-vocal sound. Disagreements were resolved through discussion.

Missing and excluded recordings

Several parents in the sample spoke to their children in a language other than English, and so these play interactions were excluded from the current study's analyses. At 2 years, there were four mothers in the control group who spoke in a language other than English, and three in the history group, while there were also two fathers in the control group who spoke in a language other than English. At 3 years, two mothers in the control group and two in the history group spoke in a language other than English, while there were two fathers in the control group and one in the history group who spoke in a language other than English. Cases where recordings of English-speaking parents were not available for

analysis were due to errors in laboratory protocol or technical difficulties in the recording process.

At the 2-year timepoint, maternal language, responsiveness and warmth analyses were based on a sample of 39 mothers, and paternal analyses were based on a sample of 24 fathers. At the 3-year timepoint, maternal analyses were conducted on a sample of 30 mothers, while the paternal sample comprised 6 fathers. 33 triadic interactions were analysable for the evaluation of coparenting quality at the 2-year timepoint. The sample breakdown of participants with available data per group is shown in Table 2.5.

Table 2.5

The number of participants whose recordings were analysed for parenting behaviours.

	Control				History				Depressed			
	Language/ warmth		Coparenting quality		Language/ warmth		Coparenting quality		Language/ warmth		Coparenting quality	
Parent	M	F	M	F	M	F	M	F	M	F	M	F
2 years	22	12	14	14	11	10	13	13	6	2	7	7
3 years	13	4	-	-	13	2	-	-	4	-	-	-

Note. M = Mother; F = Father.

2.4 Statistical Analyses

All data were analysed using SPSS (Version 26, IBM). Normality was assessed using QQ plots and Shapiro-Wilks tests. Log transformations were applied to non-normal data, and where such transformations did not produce normality, nonparametric Kruskal-Wallis tests were used to examine between-group differences. Prior to running correlational analyses, linearity was assessed using scatterplots. For cases that violated this assumption, nonparametric rank-based Spearman tests were used. Post-hoc Bonferroni tests were conducted, to correct for multiple comparisons in between-group analyses. The significance level was set at 0.05 for all analyses. Tukey's median-based hinges were used to categorise cortisol values and child developmental scores into the 25th, 50th and 75th percentiles. The 'lower hinge' represents the 25th percentile, the 'mid-hinge' is the 50th percentile (the median) and the 'upper hinge' is the 75th percentile.

At 3 years, there was less variation in size for the History and Control groups. Following a Levene's test, used to confirm homogeneity of variance, a one-way analysis of covariance (ANCOVA) was used to determine whether a significant difference in group EF scores would be observed while controlling for the effects of maternal and paternal education and child gender. These covariates were selected based on evidence that individual differences in EF have been associated with each of these factors (Montroy et al., 2016).

In the current study, two mediation analyses were conducted using PROCESS, a regression-based SPSS macro (Hayes, 2013), to test the indirect effect of coparenting support on children's adaptive scores, and the indirect effect of maternal responsiveness on children's language quality. PROCESS assesses the relationship between a predictor variable and an outcome variable, through their relationship with a mediating variable. The recommended bootstrapping method of 5000 samples, and confidence intervals of 95% were used in the current study. Several other mediation analysis methods exist, yet PROCESS was selected for use in the current study due to the small sample size.

Prior to conducting this mediation analysis, several other statistical analyses were first considered. One of the most commonly used mediation models, Baron and Kenny's (1986) approach to mediation involves four steps, the first three establishing direct linear relationships between the independent variable and the dependent variable, the independent variable and the mediator and the mediator and the dependent variable, and the last step involving a multiple linear regression with the independent variable and mediator predicting the dependent variable. If one or more of the relationships tested is

not statistically significant, it is usually concluded that mediation is not likely, which at times results in type II errors (MacKinnon et al., 2007). An alternative approach that is considered superior to this method involves calculating the indirect effect and testing its significance (Newsom, 2020). The regression coefficient for the indirect effect constitutes the change in the dependent variable for every unit change in the independent variable that is mediated by the variable under examination. Following calculation of the indirect effect coefficient, it is tested for significance or a confidence interval is obtained. Two approaches that are widely reported to perform well in testing the significance of the indirect effect are bootstrap methods and the Monte Carlo method. The PROCESS macro can be used to run either of these tests (Hayes, 2014).

In the current study, the bootstrapping method was selected as it is a non-parametric technique that does not make assumptions regarding the shape of the distribution. It is also not based on large-sample theory so it can be applied to small samples with more confidence than other mediation models (Preacher & Hayes, 2004). There are more statistically powerful ways to measure an indirect effect, including the Sobel test (Sobel, 1982). However, one of the Sobel test's assumptions is that the sample size is large (Preacher & Hayes, 2004). Furthermore, recent longitudinal research has begun to expand on simple mediation models to use structural equation modelling (SEM), which facilitates the testing of complicated models containing multiple mediators. While SEM can be used to gain deep insight into the relationships between variables in a longitudinal study, a large sample is recommended for this type of analysis and hence, was beyond the scope of the current study.

Observed power was calculated using SPSS and G*Power. First, due to the use of nonparametric tests for group comparisons, in order to calculate effect size estimates, the mean ranks for each parent and child mood and developmental outcome variable first had to be computed using SPSS. These mean ranks were then compared by participant group to calculate epsilon-squared values, which is the recommended effect size estimate for Kruskal Wallis nonparametric tests (Tomczak & Tomczak, 2014). These epsilon squared values were converted to eta squared values (Cohen, 1988) and inputted to G*Power. The sample parameters were specified and all subsequent power calculations for Kruskal-Wallis tests and ANCOVA were completed in G*Power. The power analysis function of SPSS Version 27 was used to estimate observed power for Spearman rank-based tests.

Chapter 3

Perinatal depression and children's developmental outcomes at
2 and 3 years postpartum

3.1 Introduction

Early research examining associations between perinatal depression and offspring outcomes primarily focused on symptoms occurring within the initial postnatal period. However, the past decade has seen a surge in research examining this relationship over a longer term, from pregnancy through to early childhood.

3.1.1 Perinatal depression and children's social-emotional outcomes

The key developmental domains studied in literature examining early childhood outcomes are social-emotional, cognitive and language development. Social-emotional development, encompassing children's understanding, processing and regulation of emotions is an important research area, as social-emotional deficits have been associated with an increased risk of psychiatric disorder in adolescence and adulthood (Madigan et al., 2018). Children's social-emotional functioning is typically evaluated through parental report, and clinical observation of internalising and externalising symptoms (Wolford et al., 2019). Internalising symptoms, such as social withdrawal and anxiety, and externalising symptoms, including poor impulse control and aggression, have both been associated with children's exposure to maternal perinatal depression (Goodman et al., 2011; Fransson et al., 2020).

A meta-analysis conducted by Goodman and colleagues (2011) found a stronger association between maternal depression and children's internalising symptoms in clinical samples compared to community samples. While this finding was to be expected, given that more severe maternal depression has been frequently linked with increased social-emotional issues among children, there was no significant difference in effect sizes between clinical and community samples for children's externalising symptoms (Goodman et al., 2011). Furthermore, Kingston and colleagues (2018) found no significant difference in the rates of externalising symptoms exhibited by 3-year-olds whose mothers had met diagnostic criteria for perinatal depression compared to those whose mothers had experienced high subclinical symptom levels. Such findings suggest that while children exposed to severe maternal depression have a greater likelihood of developing internalising symptoms, the risk of developing externalising issues is heightened even among children whose mothers have subclinical depressive symptoms.

3.1.2 Perinatal depression and children's cognitive and linguistic outcomes

As with social-emotional development, children's cognitive and linguistic outcomes have been negatively associated with their exposure to maternal perinatal depressive symptoms. Direct associations were reported in early studies of 1-2-year-olds (e.g. Lyons-Ruth et al., 1986; Murray et al., 1996). Murray and colleagues (1996) found that maternal depression at 6 months predicted lower child cognitive scores at 18 months, an association that held after controlling for maternal IQ. More recent support for a direct association came from Koutra and colleagues (2013), who reported independent associations between both prenatal and postnatal maternal depression and decreased cognitive development among 18-month-olds.

While such findings support the possibility of a direct pathway between perinatal depression and toddlers' cognitive functioning, another way in which cognitive deficits may arise is through the influence that perinatal depression exerts on a mother's behaviour and her parenting. Depressed mothers tend to provide less contingent stimulation, which is associated with lower learning task performance (Dunst et al., 2007; Yan & Dix, 2016). Furthermore, infants typically mirror their mothers' affect, which tends to be more negative among depressed mothers, and infants' own negative affect has been found to interfere with their information-processing ability (Singer & Fagen, 1992). Another way in which maternal depression can indirectly impact children's cognitive functioning was demonstrated by Wu and colleagues' (2018) longitudinal study of maternal investment in child development. Severely depressed mothers provided less emotional and material support to their children at every timepoint (1, 5, 10, and 16 years), which was significantly associated with children's lower IQ scores.

The development of higher-order cognitive skills – executive function (EF) – has also been examined in relation to maternal perinatal depression. There is a lack of consensus in this area of the literature, with some studies reporting null findings (Klimes-Dougan et al., 2006; Micco et al., 2009; Rhoades et al., 2011), and others reporting significant differences in children's EF ability, depending on their prior exposure to perinatal depression (Hughes et al., 2013; Park et al., 2018). Hughes and colleagues (2012) examined the maternal depression and children's EF from 2 to 6 years postpartum and proposed that the potential impact of perinatal depression on children's EF depends largely on the chronicity of maternal depressive symptoms. Hughes et al. (2013) found that reductions in maternal depression over time were associated with improvements in children's EF ability. Hence, EF may represent one facet of development that is

particularly receptive to enhancements in a child's postnatal environment, throughout early childhood.

In the area of language development, perinatal depression has been negatively implicated with children's outcomes (Aoyagi & Tsuchiya, 2019; Feldman & Eidelman, 2009; Sutter-Dallay et al., 2011). However, there is a lack of consensus across the literature, with several studies reporting no direct link between the two variables (e.g. Kaplan et al., 2014; Keim et al., 2011; Stein et al., 2008). Most studies that have reported negative associations between maternal perinatal depression and children's linguistic functioning have suggested that this effect arises due to reduced rates of 'scaffolding' or learning-supportive parenting behaviours, typically observed among depressed mothers (Kaplan et al., 2014). Taken together, it seems that perinatal depression may influence children's linguistic development through its adverse impact on parenting behaviours.

3.1.3 Perinatal depression and the role of fathers in child development

Research examining the impact of perinatal depression on children's outcomes has predominantly focused on the influence of mothers. However, more recently, research on perinatal depression has broadened its focus to investigate the impact that fathers may have on offspring development. This influence has primarily been examined in two contexts: the first, in cases where fathers themselves have perinatal depression, and the second, in cases where non-depressed fathers may play a protective role in the development of children exposed to maternal perinatal depression.

Paternal perinatal depression has been associated with various adverse child outcomes. In the area of social-emotional development, children of depressed fathers have been found to have a significantly greater risk of experiencing internalising and externalising issues, even after controlling for maternal depression (Fletcher et al., 2011, Ramchandani et al., 2005; Ramchandani et al., 2008). This effect was observed at 3 and 7 years postpartum (Ramchandani et al., 2005; Ramchandani et al., 2008), and has been found to persist beyond childhood, into adolescence. In a systematic review conducted by Sweeney and MacBeth (2016), fathers' experiences of depression in either the antenatal or postnatal period were significantly associated with offspring experiences of internalising and externalising issues during adolescence.

While most research examining the impact of paternal perinatal depression on children's development has focused on social-emotional outcomes, some studies have examined the impact that paternal perinatal depression may have on children's cognitive

development. Roggman and colleagues (2004) reported a significant negative association between the two variables which was proposed to arise from depressed fathers' observed tendency to engage in less varied play with their 2-year-olds. In an ALSPAC study of parental depression and child development, Gutierrez-Galve and colleagues (2015) examined the individual contributions of maternal and paternal depression to children's early outcomes. Maternal depression and marital conflict were found to mediate two-thirds of the overall association between paternal depression and children's outcomes at 3 years. Conversely, paternal depression and marital conflict accounted for approximately one-quarter of the association between maternal depression and children's development. Hence, it seems that a large part of the association between paternal perinatal depression and children's subsequent outcomes may be explained by the mediating role of key family factors including maternal depression, while maternal depression and children's development have a more direct relationship.

Other studies have provided support for the protective role that fathers can play in their children's cognitive development. For example, paternal responsiveness has been found to independently account for variation in 2- and 3-year-old children's current and subsequent cognitive scores (Tamis-LeMonda et al., 2004; Cabrera et al., 2007). Furthermore, Towe-Goodman and colleagues (2014) found that paternal responsiveness during play interactions with 2-year-olds was positively associated with children's subsequent Executive Function (EF) scores when they were 3-5 years of age. The contribution made by paternal responsiveness to children's EF outcomes was significantly greater than that of maternal responsiveness (Towe-Goodman et al., 2014). Such findings support the view that non-depressed fathers may play an important role in buffering the impact of maternal perinatal depression on their children's development.

In the area of language development, fathers have been posited to play a unique role in children's early language learning. Pancsofar and Vernon-Feagans (2010) reported a significant positive association between the quality of fathers' language during play interactions with their 2-year-olds and children's subsequent expressive linguistic ability at 3 years. This association held after controlling for family demographics, maternal education, and the quality of maternal language. Hence, fathers can help to mitigate the adverse linguistic outcomes that may arise from children's exposure to maternal perinatal depression. However, in cases where fathers are depressed, young children's language development may be more adversely impacted. For example, in Paulson and colleagues' (2006) study of parents' reading behaviours, perinatal depression measured at 9 months

postpartum was negatively associated with both mothers' and fathers' participation in reading activities with their children. However, only paternal depression at 9 months was negatively associated with fathers' later reading at 2 years, which was also significantly associated with offspring expressive language outcomes. Taken together, these findings suggest that fathers may significantly impact children's development in distinct ways: non-depressed fathers may play an important buffering role in the development of children exposed to maternal perinatal depression, while depressed fathers may be impacted by their depression in a similar manner to depressed mothers, and display an increased tendency to engage in maladaptive parenting, thus impeding their ability to provide adequate support for young children's learning.

3.1.4 The current study

The current study is part of a larger longitudinal study by the REDEEM group (REsearch in Depression, Epigenetics, Endocrinology and NeuroIMaging), which sought to examine the relationships between Major Depressive Disorder (MDD) during the perinatal period and children's developmental outcomes, from pregnancy through to toddlerhood.

O'Leary and colleagues (2019) reported on maternal depression and infants' outcomes at the study's earlier 2-, 6-, and 12-month timepoints. The current study is based on data collected at the study's final two timepoints – 2 and 3 years postpartum. While the earlier timepoints focused on mothers' depression and offspring outcomes, the study's scope was broadened for these final timepoints to also include fathers. Parents' depression was assessed using Hamilton Depression Rating Scale (HAM-D)-based interviews. At 2 years, children's social-emotional, cognitive, language and adaptive development were assessed using the Bayley Scales of Infant Development (BSID-III). At 3 years, the same developmental domains were examined, with the exception of children's cognitive development, which was substituted by an Executive Function higher-order cognitive assessment. Consistent with prevalent findings in the literature, the following hypotheses were formed for each developmental domain:

Hypothesis 1: Social-Emotional Development

Consistent with previous literature (e.g. Goodman et al., 2011), we hypothesised that children's SE scores would be negatively associated with mothers' antenatal group placement, and depression scores. As several studies have also reported significant links between children's SE and parents' concurrent depression severity, we predicted that

elevated maternal and paternal depression scores at 2 and 3 years would be negatively associated with children's SE scores at these timepoints.

Hypothesis 2: Cognitive Development

In line with the direct negative associations between perinatal maternal depression scores and children's cognitive outcomes reported by studies that used similar measures (Lyons-Ruth et al., 1986) and a similar age group (Murray et al., 1996), we hypothesised that elevated antenatal and concurrent maternal depression scores would be negatively associated with children's cognitive scores at 2 years.

Hypothesis 3: Executive Function

While there is a lack of consensus in literature examining the relationship between children's exposure to perinatal depression and their EF development, a significant association between the two variables has been reported (Hughes et al., 2013; Park et al., 2018). Based on Hughes and colleagues' (2013) findings, we hypothesised that there would be a significant difference in the EF scores of 3-year-olds who had been exposed to perinatal depression versus those who had not. As EF development appears to be particularly susceptible to the quality of children's postnatal input, this hypothesis will be re-examined in a later chapter, in which parental responsiveness will be evaluated for its potential role in the relationship between perinatal depression and children's EF ability.

Hypothesis 4: Language Development

The majority of studies that have found a significant negative association between perinatal depression and children's language outcomes have attributed this finding to the impact that depression may have on the quality of parenting and speech input (e.g. Kaplan et al., 2014). It appears that the relationship between children's exposure to parental depression and language outcomes may be mediated by maladaptive parenting behaviours associated with depression. The analyses presented in the current study are based solely on parents' depression and children's developmental scores. Hence, we hypothesise that there will be an inverse association between parental depression scores and children's language scores at 2 and 3 years postpartum. This hypothesis will be re-examined in chapter 6, which will consider the impact of parenting behaviours on children's linguistic outcomes.

Hypothesis 5: Adaptive Behaviour

This domain is based on a BSID-III questionnaire completed by mothers. To our knowledge, this scale has not been previously examined in relation to parental perinatal depression. The BSID-III defines this scale as one which assesses “the daily functional skills of a child, measuring what the child actually does, in addition to what he or she may be able to do.” Children’s general functioning has been negatively associated with maternal depression, and depressed mothers tend to rate their children more negatively on behavioural questionnaires (Muller & Furniss, 2013). Hence, we hypothesised that elevated maternal depression scores would be negatively associated with children’s adaptive behaviour scores at 2 and 3 years.

3.2 Method

3.2.1 Participants

At the first timepoint of the study, one hundred women in their second or third trimester of a singleton pregnancy were recruited from three maternity hospitals in Dublin. A research registrar in Psychiatry used the DSM-IV-TR (APA, 2000) diagnostic criteria for Major Depressive Disorder (MDD) to stratify participants into one of three groups: Depressed ($n = 23$), History of Depression ($n = 34$) and Control ($n = 43$). The ‘History of Depression’ participants were euthymic during pregnancy but had suffered at least one previous MDD episode. Participants in the control group had no history of psychiatric disorder. Follow-ups were conducted when children were approximately 2, 6, 12, 24 and 36 months old.

The 2, 6 and 12 month follow-ups consisted of home visits, in which mothers’ depression was assessed using the Hamilton Depression Rating Scale (HAM-D; Hamilton, 1960) and infant developmental outcomes were measured using the Neonatal Behavioural Assessment Scale (NBAS [Brazelton, 1978], at 2 and 6 months) and the Bayley Scales of Infant Development (BSID-III [Bayley, 2006], at 12 months). The 2- and 3-year follow-ups took place in the Trinity College Infant and Child Research Laboratory, recruitment for which was carried out through emails and telephone calls. Sixty-one mothers, forty-one fathers, and their children (M age = 26.28 months, $SD = 1.83$; 35 boys and 26 girls) participated in the study at 2 years. The demographic characteristics of mothers who remained in the study at this timepoint is provided in Table 3.1.

Forty-two mothers and fifteen fathers participated at the 3-year timepoint. The mean age of participating 3-year-olds was 38.35 months ($SD = 1.76$), and the sample comprised 25 boys and 17 girls. 15 fathers participated in person at 3 years, while an additional 10 fathers, who were not available to attend the laboratory appointment, provided mood- and child development-related questionnaire data. The study's flow of participants, from pregnancy through to 3 years postpartum, was provided in Chapter 2, and the participants who remained in the study at 2 and 3 years is shown in Figure 3.1. Attrition rates per participant group are displayed in Table 3.1.

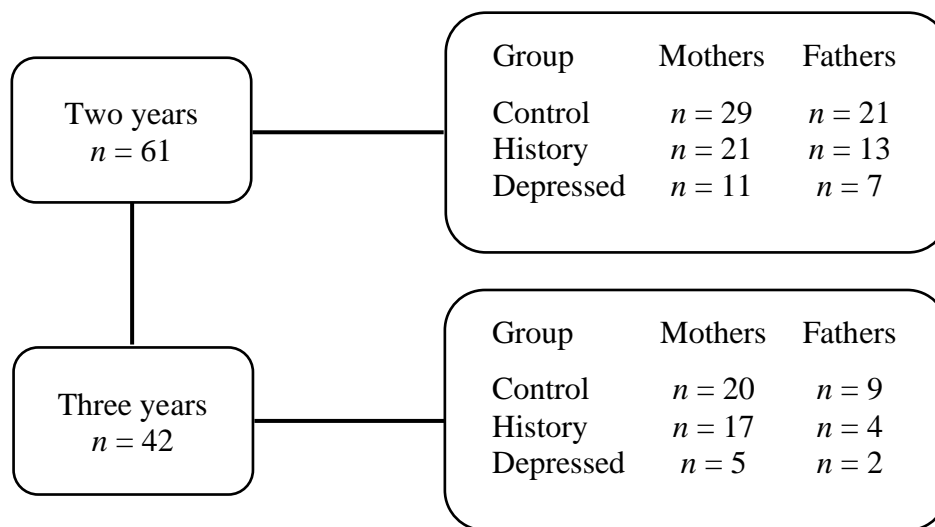


Figure 3.1. Sample composition at 2 and 3 years postpartum.

Table 3.1*Group attrition rates.*

	n at baseline	n at 2 years	n at 3 years	Attrition rate
Control	42	29	20	52.38%
History	33	21	17	48.48%
Depressed	23	11	5	78.26%

The proportion of participating fathers partnered with mothers in each participant group is shown in Table 3.2.

Table 3.2*The proportion of fathers partnered with mothers in each group at the 2- and 3-year timepoints.*

	Control (n, %)	History (n, %)	Depressed (n, %)
2 years	21 (51.2%)	13 (31.7%)	7 (17.1%)
3 years	9 (60%)	4 (26.7%)	2 (13.3%)

3.2.2 Sample attrition

A chi square test demonstrated that mothers' experience of antenatal MDD was significantly associated with cessation of participation prior to the 2-year timepoint, $\chi^2(1) = 7.07, p = .008$. An additional chi square test provided statistical support for an association between mothers' antenatal depression severity and their drop-out prior to the 2-year timepoint, $H(4) = 11.85, p = .018$. A series of Fisher's Exact tests were conducted to compare the demographic characteristics of participants who remained in the study at 2 and 3 years versus those who had dropped out. No statistically significant differences were observed among participants who remained versus those who dropped out for any demographic characteristic.

3.2.3 Parental measures

At the 2- and 3-year timepoints, parents' depression severity was assessed through interviews based on the Hamilton Depression Rating Scale (HAM-D, Hamilton, 1960). Parents also completed self-report questionnaires at both timepoints: the Center for

Epidemiologic Studies: Depression Scale (CES-D; Radloff, 1977), and the Perceived Stress Scale (PSS) (Cohen et al., 1983). Details of these measures have been provided in Chapter 2.

3.2.4 Child measures

Bayley Scales of Infant Development-3rd Edition (BSID-III) (Bayley, 2006)

The cognitive and language scales of the BSID-III were administered at the study's 2-year timepoint, while only the language scales were administered at 3 years. Raw scores were tallied, and the BSID-III manual was used to compute scale scores, which are dependent on the child's age in months and weeks. The language scale comprises two subscales: receptive and expressive, which produce two separate scale scores. These scores were summed and converted to an overall language composite score. At 2 years, cognitive scale scores were similarly converted to composite scores. All BSID-III composite scores were scaled to a metric range of 40 to 160 ($M = 100$, $SD = 15$), and used to represent children's developmental abilities in the current study's analyses.

Bayley-III Social-Emotional Scale (Greenspan, 2004)

A 35-item questionnaire designed to evaluate a child's social-emotional development was completed by mothers. Raw scores were summed and converted to an age-dependent scale score, which was then used to produce a social-emotional composite score.

Bayley-III Adaptive Behaviour Scales (Harrison & Oakland, 2003)

The 241-item Adaptive Behaviour questionnaire was completed by mothers and used to assess children's daily independent living skills. The Adaptive Behaviour Scale comprises three subscales: Conceptual, Practical, and Social Adaptive Behaviour, the composite scores for which were used to examine group differences in the current study. The total scores for each of these scales were also tallied and converted to an overall General Adaptive composite score.

Executive Function (Willoughby et al., 2010)

Five tasks from a test battery designed to assess children's Executive Function (EF) ability were administered at the 3-year timepoint. A child's correct responses were summed to produce an overall EF composite score, with a maximum possible score of 44. The order of tasks was counter-balanced across participants, in order to mitigate potential

fatigue effects on a child's performance. Further details of this test battery were provided in Chapter 2.

3.2.5 Statistical analyses

All data were analysed using SPSS (Version 26, IBM). Normality was assessed using QQ plots and Shapiro-Wilks tests. Due to uneven group sizes and heterogeneity of variance among the three participant groups, nonparametric Kruskal-Wallis tests were used to compare group differences. Bonferroni corrections for multiple comparisons were run for all analyses. First, Kruskal-Wallis tests were conducted to examine group differences in mothers' and fathers' mood scores (HAM-D, CESD and PSS). In order to examine differences in mothers' HAM-D scores over time, a Friedman test – the nonparametric equivalent of a repeated measures ANOVA – was conducted, due to the lack of sphericity and heterogeneity of variance observed in the data. Prior to running correlational analyses, linearity was assessed using scatterplots. Due to a lack of linearity in the data, nonparametric rank-based Spearman tests were used to examine the continuity of parental HAM-D scores from the 2-year timepoint to the 3-year timepoint.

In order to examine the first and second hypotheses – that children's SE and cognitive scores would be negatively associated with mothers' antenatal group placement and mothers' and fathers' depression scores – Kruskal-Wallis tests and Bonferroni corrections for multiple comparisons were conducted to examine between-group differences. Nonparametric tests were again selected due to uneven group sizes and heterogeneity of variance. Spearman rank-based tests were conducted to examine associations among parents' depression scores and children's SE and cognitive scores.

Kruskal-Wallis tests were also conducted to examine the third hypothesis, which predicted that children who were exposed to antenatal depression would have significantly lower EF scores compared to those who had not. Homogeneity of variance among the Control and History groups at the 3-year timepoint was confirmed using a Levene's test. Due to this homogeneity and less variation in the size of the History and Control groups at this timepoint, a one-way analysis of covariance (ANCOVA) was conducted to examine potential group differences in children's EF at 3 years. Maternal and paternal education and child gender were selected as covariates for the analysis based on the literature (Montroy et al., 2016). A Bonferroni correction for multiple comparisons was also applied.

In order to examine the fourth hypothesis, which predicted that children's language scores would be negatively associated with mothers' antenatal group placement and parents' depression scores, Kruskal-Wallis tests and Bonferroni corrections were used to examine between-group differences. Spearman rank-based tests were conducted to examine associations between children's language scores and parents' antenatal or current depression scores. In order to examine our final hypothesis – that mothers' antenatal group placement and current depression scores would be negatively associated with children's conceptual, practical and social adaptive behaviour, between group differences were examined using Kruskal-Wallis tests and Bonferroni corrections. Spearman rank-based tests were used to examine associations between parents' depression scores and children's scores in each general adaptive domain.

3.3 Results

3.3.1 Maternal perinatal depression

At the 2-year timepoint, mothers' HAM-D scores indicated that 75.9% ($n = 22$) of the Control group had few or no depressive symptoms, 20.7% ($n = 6$) had mild depression and 3.4% ($n = 1$) had moderate depression. 61.9% ($n = 13$) of mothers in the History group had few or no depressive symptoms, 33.3% ($n = 7$) had mild depression and 4.8% ($n = 1$) had moderate depression. Within the Depressed group, 45.4% of mothers ($n = 5$) had few or no depressive symptoms, 36.4% ($n = 4$) had mild depression, 9.1% ($n = 1$) had moderate depression, and 9.1% ($n = 1$) had severe depression.

At the 3-year timepoint, 75% ($n = 15$) of mothers in the Control group had few or no depressive symptoms, 20% ($n = 4$) had mild depression, and 5% ($n = 1$) had moderate depression. 17.7% ($n = 3$) of mothers in the History group had few or no depressive symptoms, 47.1% ($n = 8$) had mild depressive symptoms, 23.5% ($n = 4$) had moderate depression, and 11.8% ($n = 2$) had severe depression. 40% ($n = 2$) of mothers in the Depressed group had few or no depressive symptoms, 40% ($n = 2$) had mild depressive symptoms, while 20% ($n = 1$) had moderate depression. symptoms.

The recommended cut-off for depression caseness (scores ≥ 17) was used to examine the proportion of mothers in each group that met HAM-D score criteria for depression at 2 and 3 years. Descriptive data for each group are displayed in Table 3.3.

Table 3.3

The proportion of mothers in each group that obtained HAM-D scores indicative of depression caseness at 2 and 3 years.

	Mothers' antenatal group		
	Control	History	Depressed
Depression case at 2 years (n, %)	1, 3.5%	0, 0%	3, 28.8%
Depression case at 3 years (n, %)	1, 5%	4, 23.5%	1, 20%

3.3.2 Maternal depression severity

Descriptive data for maternal mood scores are provided in Table 3.4. Due to uneven group sizes and heterogeneity of variance, group differences in mothers' mood scores were assessed using Kruskal-Wallis tests. The results of these between-group tests can also be seen in Table 3.2, alongside the adjusted p values, which were obtained using Bonferroni corrections for multiple comparisons. The proportions of mothers in each group that displayed each HAM-D depression severity category at the 2- and 3-year timepoints are depicted in Figure 3.2.

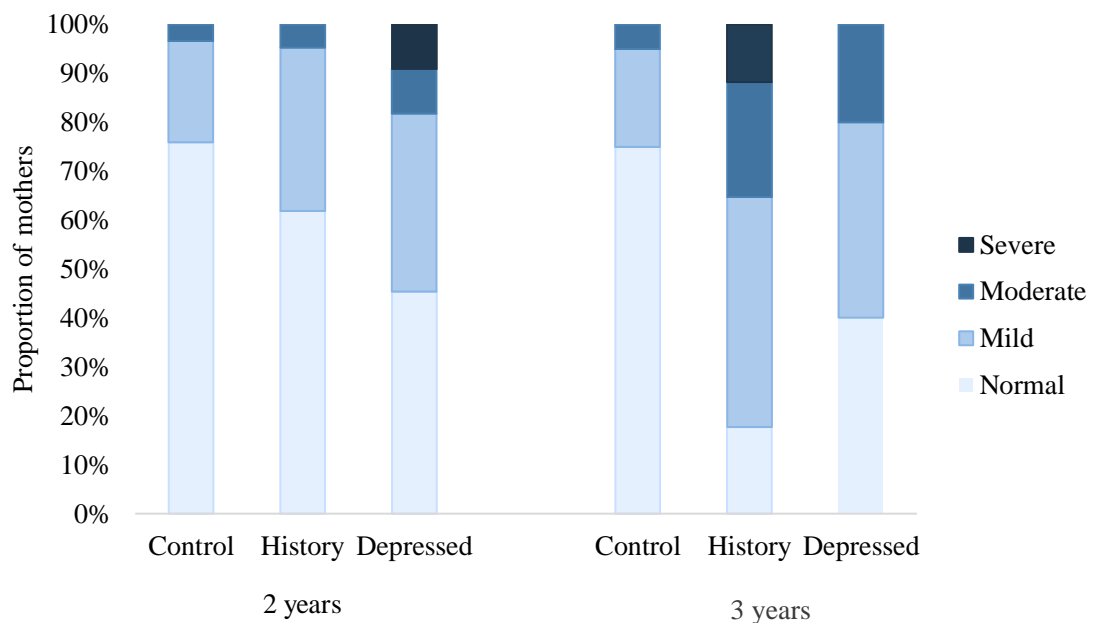


Figure 3.2. The HAM-D depression severity displayed by mothers at 2 and 3 years.

Table 3.4*Descriptive data for maternal mood measures at 2 and 3 years.*

Timepoint	Measure	Control		History		Depressed		Group comparisons Test statistic, <i>p</i> value
		Mdn	IQR	Mdn	IQR	Mdn	IQR	
2 years	HAM-D	3	6	6	6.25	3	14	$H(2) = 7.002, p = .046^{ac}$
	CES-D	3.5	3.75	7	7.5	9	16.75	$H(2) = 12.557, p = .005^{abc}$
	PSS	16.5	11.5	25.5	9.25	21	17.5	$H(2) = 10.231, p = .007^{ac}$
3 years	HAM-D	3	3.75	13	7	6	14.25	$H(2) = 10.126, p = .004^{ac}$
	CES-D	6	10.5	13	16	7.5	25.5	$H(2) = 4.396, p = .111^c$
	PSS	14.5	10	26	11	17.5	20.5	$H(2) = 8.372, p = .013^{ac}$

^a Significant difference between the Control and History of Depression groups.

^b Significant difference between the Control and Depressed groups.

^c No significant difference between Depressed and History of Depression groups.

Due to a lack of sphericity, and heterogeneity of variance, a Friedman test – the nonparametric equivalent of a repeated measures ANOVA – was used to examine differences in mothers' HAM-D scores over time. Due to significant attrition in the History and Depressed groups, only the Control group contained the required number of cases to compare scores at each study timepoint; no significant difference in this group's scores was observed: $\chi^2(5) = 5.699, p = .223$. The continuity of maternal HAM-D scores from the 2- to 3-year timepoints was assessed using Spearman correlations, and a strong positive association was observed, $r_s = .557, p = .004$. The median maternal HAM-D scores for each group at every timepoint are displayed in Figure 3.3.

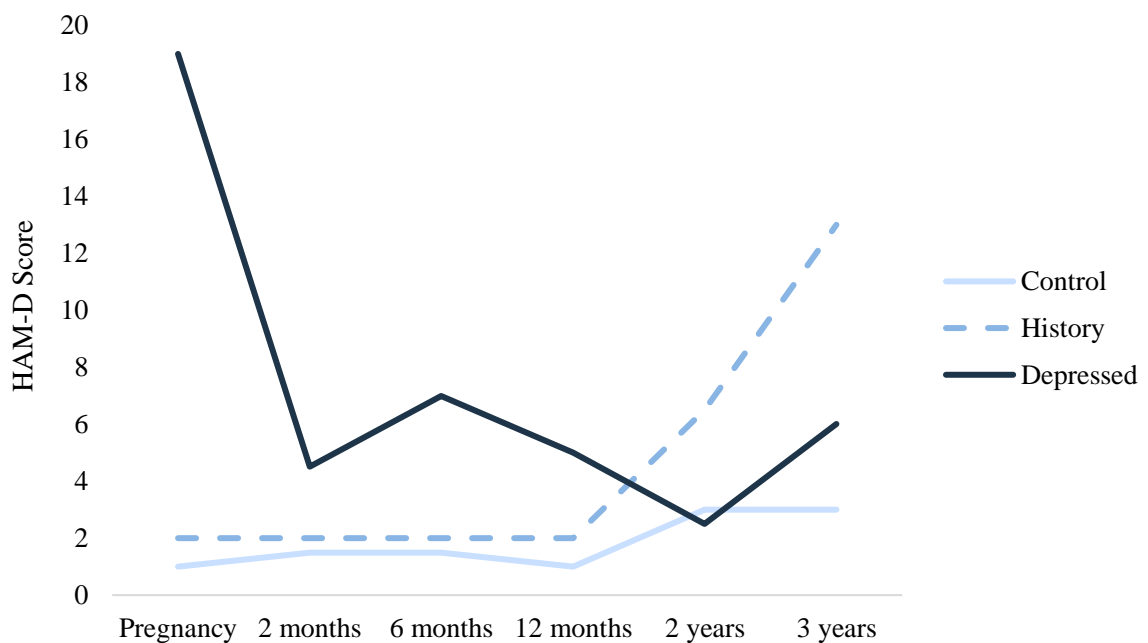


Figure 3.3. Median depression scores for each participant group over time.

3.3.3 Paternal perinatal depression

At the 2-year timepoint, fathers' HAM-D scores indicated that 90.2% ($n = 37$) had few or no depressive symptoms, 4.9% ($n = 2$) had mild depressive symptoms, 2.4% ($n = 1$) had moderate depressive symptoms, and 2.4% ($n = 1$) had severe depressive symptoms. At the 3-year timepoint, 80% ($n = 12$) of fathers had few or no depressive symptoms and 20% ($n = 3$) had mild symptoms. When the recommended HAM-D cut-off for depression caseness was examined among fathers, 4.8% ($n = 2$) had scores indicative of depression caseness at 2 years, while no fathers had scores indicative of depression caseness at 3 years.

Kruskal-Wallis tests were conducted to compare fathers' HAM-D, CES-D and PSS scores between groups at 2 and 3 years. There was no significant difference between groups' mood scores at 2 years, or for fathers' 3-year HAM-D and PSS scores. However, at the 3-year timepoint there was a significant difference in the CES-D scores of fathers partnered with mothers in the Depressed group versus those whose partners in the Control group. The mean rank score for fathers in the Depressed group was 19.50, compared to 8.59 for the Control group, $H(2) = 8.335$, $p = .015$. The significance of this group difference held after applying a Bonferroni correction for multiple tests. The continuity of paternal HAM-D scores from the 2- to 3-year timepoints was assessed using Spearman correlations, and a strong positive association was observed, $r_s = .679$, $p = .003$.

3.3.4 Perinatal depression and children's social-emotional outcomes

Descriptive data for children's developmental scores at the 2- and 3-year timepoints are provided in Table 3.5. Due to uneven group sizes and heterogeneity of variance, Kruskal-Wallis tests were used to examine between-group differences for children's social-emotional BSID-III scores, and no significant differences were found. Post-hoc analyses indicated that this test had 10.67% observed power. This analysis was based on an epsilon-squared effect size of .012, which represents a very small effect. Hence, there was an 89.33% likelihood that true group differences would not be detected in children's social-emotional outcomes. Spearman rank-based tests found no significant correlations between mothers' antenatal or either parents' current depression scores and children's scores for social-emotional development at 2 or 3 years postpartum.

3.3.5 Perinatal depression and children's cognitive and language outcomes

Kruskal-Wallis tests indicated no significant between-group differences for children's cognitive or language scores at 2 years. The observed power estimates for these tests were 32.62% and 26.52% respectively. Furthermore, there were no significant group differences for children's language outcomes at 3 years. Spearman rank-based tests indicated that there were no significant correlations between mothers' antenatal depression and children's cognitive and language outcomes. There were also no significant associations between mothers' or fathers' concurrent depression scores and children's cognitive and language scores (see Table 3.6).

Table 3.5*Descriptive data for children's developmental scores at 2 and 3 years.*

Timepoint	Domain	Control		History		Depressed	
		Mdn	IQR	Mdn	IQR	Mdn	IQR
2 years	SE	105	30	115	27.5	105	35
	Cognitive	110	25	102.5	15	100	27.5
	Language	112	27	98.5	19.5	109	41
	GA	93	19	92	15.8	104	13
3 years	SE	112.5	15	125	32.5	125	28.75
	EF	31.5	12	26.5	10	37.5	19.75
	Language	106	14.25	109	6	115	16.5
	GA	99	10.75	100.5	18.25	104	17.75

Note. SE = Social-emotional; GA = General Adaptive; EF = Executive Function.

3.3.6 Perinatal depression and children's EF

At 3 years, a Kruskal-Wallis test of children's EF scores indicated a significant difference between the History and Control groups, with mean rank scores of 14.23 versus 26.50 respectively, $H(2) = 6.859$, $p = .032$. As there was less variation in size for the History ($n=17$) and Control ($n=20$) groups at this timepoint, and homogeneity of variance was confirmed using a Levene's test, a parametric analysis could be conducted. A one-way analysis of covariance (ANCOVA) was used to determine whether a significant difference in group EF scores would be observed while controlling for the effects of maternal and paternal education and child gender. These covariates were selected based on evidence that individual differences in EF have been associated with each of these factors (Montroy et al., 2016). There was a significant group effect on children's EF scores, after controlling for child gender and parents' education levels, $F(2,26) = 3.639$, $p = .040$. However, the significance of this effect attenuated following a Bonferroni correction for multiple comparisons, yielding an adjusted p value of .069, $\eta p^2 = .216$. The observed power for this ANCOVA was 59.3%.

Table 3.6

Spearman correlation coefficients for children's developmental scores and parents' depression scores at 2 and 3 years.

Children's developmental scores	Mothers' antenatal HAM-D	Mothers' 2-year HAM-D	Fathers' 2-year HAM-D	Mothers' 3-year HAM-D	Fathers' 3-year HAM-D
<i>2 years</i>					
SE	.175	-.100	-.183	.089	-.059
Cognitive	-.127	-.095	-.097	-.07	-.043
Language	-.055	-.013	.183	-.134	.03
GA Conceptual	.259	.203	.340*	.07	.254
GA Practical	.260*	.272*	.237	-.113	.085
GA Social	.438**	.429**	.112	.174	.31
GA Composite	.260*	.290	.276*	.004	.339
<i>3 years</i>					
SE	.059	.134	-.127	.093	-.25
EF	.039	.412**	-.197	.112	.278
Language	.124	.122	-.254	.07	-.096
GA Conceptual	.151	.419*	-.206	.249	-.084
GA Practical	.184	.262	-.23	.233	.371
GA Social	.051	.141	.044	-.114	-.114
GA Composite	.107	.391*	-.18	.322*	.242

Note. SE = Social-emotional; GA = General Adaptive; EF = Executive Function;

* $p < .05$; ** $p < .01$.

3.3.7 Perinatal depression and children's general adaptive behaviour

The three subscales of the BSID-III General Adaptive (GA) Behaviour scale (Conceptual, Practical and Social) were analysed using Kruskal-Wallis tests, to detect group differences in children's scores.

At 2 years, a significant difference was found for children's Social Adaptive Behaviour, $H(2) = 8.13$, $p = .017$ (with mean rank scores of 23.17 for Control, 28.55 for History and 40.72 for Depressed). The significant difference between the Control and Depressed group scores held following a Bonferroni correction for multiple comparisons ($p = .013$). Post-hoc analyses indicated that this between-groups test had 62.5% statistical power. Hence, there was a 37.5% likelihood that true group differences would not be detected in children's social adaptive outcomes. This was based on an epsilon-squared effect size estimate of .19 which represents a medium effect (Rea & Parker, 1992).

Spearman rank tests found moderate positive correlations between children's Social Adaptive scores and maternal current depression scores (observed power = 81.7%) and those during pregnancy (observed power = 82.5%). There was a weak association between Practical Adaptive scores and both current depression scores (observed power = 54.5%) and those during pregnancy (observed power = 51.3%). Weak positive correlations were also observed between paternal current depression scores and children's overall General Adaptive (40.3% observed power) and Conceptual composite scores (56.5% observed power).

At 3 years, Kruskal-Wallis tests indicated no significant difference between groups for any domain of children's adaptive behaviour. Spearman rank-based correlations indicated that there was a statistically significant, weak positive association between mothers' current depression scores and children's General Adaptive composite scores (53.4% observed power). Fathers' depression scores were not found to correlate with any measure of child development at 3 years. All Spearman rank test results are displayed in Table 3.6.

3.4 Discussion

3.4.1 Perinatal depression and children's social-emotional development

The first hypothesis sought to examine differences in the social-emotional (SE) scores of children who had been exposed to perinatal depression, versus those who had not. The current study's finding – that there was no significant difference in SE scores across groups (Depressed, History of Depression and Control) at 2 and 3 years postpartum – was contrary to what had been predicted. Exposure to antenatal depression is considered a significant risk factor for children's social-emotional development (Glover, 2014; Junge et al., 2017). However, some perinatal depression researchers have emphasised the importance of examining the influence of perinatal depression on child development in terms of symptom chronicity as well as severity. This is important as social-emotional deficits are more likely to occur in children whose parents have both severe and persistent perinatal depression (Brennan et al., 2000; Prenoveau et al., 2017). While techniques such as group-based trajectory modelling have been used to compare differences in children's outcomes based on parents' depressive symptom trajectory throughout early childhood (Prenoveau et al., 2017), this type of analysis is inappropriate for small samples and hence, could not be conducted for the current study. It is likely that the sample's attrition rate, which was higher among mothers from the original Depressed group, compared to the Control group, also played a role in minimising any group differences in social-emotional outcomes.

3.4.2 Perinatal depression and children's cognitive development

In line with previous studies of a similar design (Murray et al., 1996; Koutra et al., 2013), it was hypothesised that elevated perinatal depression would be negatively associated with children's cognitive scores at 2 years. However, these scores were not significantly associated with either antenatal maternal, or postnatal maternal or paternal depression levels. The studies upon which our hypothesis was based reported direct negative associations between children's cognitive functioning and exposure to perinatal depression. However, the overall literature related to the cognitive outcomes of depressed parents' offspring has lacked consensus. While our finding may be linked to sample attrition, it may also align with previous research that has proposed the adverse cognitive outcomes associated with perinatal depression to result from maladaptive parenting associated with more severe cases of parental depression. For example, infants' tendency to mirror depressed mothers' negative affect can interfere with their information-

processing ability (Singer & Fagen, 1992), and depressed parents tend to provide less effective scaffolding, or appropriate guidance during tasks, to their children (Hoffman et al., 2006).

3.4.3 Perinatal depression and children's executive function

The current study hypothesised that children's EF would be significantly lower among children whose parents were depressed compared to their non-depression-exposed peers. While the initial ANCOVA result indicated that children's EF scores were significantly lower in the History of Depression group compared to the Control group, this finding attenuated following a Bonferroni correction for multiple comparisons. While this correction deemed the result as not statistically significant at the .05 level set for our analyses, some researchers may describe the adjusted p value of .069 as 'approaching statistical significance' (Morgan, 2018). In the current study, parental education levels and child gender were selected as covariates for children's EF ability, and the initial result was statistically significant while controlling for these variables. Hence, while it is important to interpret results using the significance level set from the beginning, it is also possible that the current study's small sample size limited our ability to detect a true difference between groups for children's EF.

The Spearman rank-based results may be indicative of a nuanced relationship between perinatal depression exposure and children's EF development. Mothers' 2-year, but not 3-year depression scores were found to be positively moderately correlated with children's EF scores at 3 years. This finding indicates that children who were exposed to elevated maternal depression at 2 years showed superior EF functioning at 3 years. This may reflect cases where mothers of children, exposed to depression at an earlier stage of development, have since experienced a decrease in symptom severity and hence, are more likely to engage in positive parenting behaviours. This would be consistent with Hughes and colleagues' (2013) longitudinal study, which found that reductions in maternal depressive symptoms over time predicted subsequent improvements in 3-6-year-old children's EF (Hughes et al., 2013). As Executive Function is considered to be particularly susceptible to the effects of parenting quality, this aspect of development will be re-examined in a later chapter, which will investigate the potential moderating role of parental responsiveness in the relationship between perinatal depression and children's EF.

3.4.4 Perinatal depression and children's language development

The current study's lack of direct association between parental depression scores and children's language is consistent with our hypothesis, based on previous research. Several factors specific to this study may also account for this finding. It is likely that mothers who have mild depression are more capable of maintaining a supportive learning environment than mothers who are very severely depressed (Prenoveau et al., 2017). Hence, important aspects of parenting, such as responsiveness and engagement in scaffolding behaviours – which are associated with enhanced language development – may not be impaired in the current sample.

Furthermore, other caregivers may play an effective buffering role in the child's learning environment. For example, previous research has identified sensitive fathering as a key mitigator for the adverse effects of maternal depression (Vakrat et al., 2018). Additionally, non-clinical children's language research has provided support for the idea that fathers may uniquely contribute to young children's linguistic development. Pancsofar and Vernon-Feagans (2006, 2010) reported that the quantity of fathers' linguistic output during parent-child play interactions – but not mothers' – was positively associated with children's expressive language outcomes at 2 and 3 years. A later chapter will examine the potentially mediating influence that parents' behavioural and vocal input may have on children's language development.

3.4.5 Perinatal depression and children's adaptive behaviour

To the author's knowledge, the BSID-III Adaptive Behaviour scale – used to evaluate “the daily functional skills of a child, measuring what the child actually does, in addition to what he or she may be able to do” (Bayley, 2006) – has not been previously examined in relation to perinatal depression. Due to the strong links between children's general adaptive behaviour and other aspects of development, we hypothesised that children's scores for this domain would also be negatively associated with parental depression. In the current study, several aspects of children's adaptive behaviour were found to correlate with parental depression, in the opposite direction to what had been predicted. At 2 years, weak positive correlations were observed between maternal depression scores and children's practical adaptive scores, and paternal depression scores and children's conceptual adaptive scores. At 3 years, only one statistically significant association was observed – a positive association between mothers' current depression scores and children's general adaptive composite scores.

The strongest positive associations in the study were observed between maternal antenatal and 2-year depression scores, with children's social adaptive behaviour, which were highly statistically significant, $p < .001$. Most of the perinatal depression literature on children's social adaptive functioning reports negative associations between the two variables, in older children. For example, in a sample of 5–7-year-olds, the offspring of mothers who had experienced postnatal depression displayed less prosocial behaviour and were teacher-rated as less popular with their peers (Kersten-Alvarez et al., 2012). In adolescent samples, offspring of depressed mothers have been found to have lower quality relationships and less competent social skills than their peers with non-depressed mothers (Hammen & Brennan, 2003). However, no previous research has examined the social skills (as distinct from general social-emotional development) of depressed mothers' 2-year-olds.

Children who have been exposed to adverse conditions and display no developmental deficits may be termed 'resilient' (Giallo et al., 2018). Recent research has expanded beyond protective factors for high-risk children to examine 'resource factors', which may promote positive functioning among children in both high- and low-risk contexts (Giallo et al., 2018). Resource factors are particularly relevant to the current sample, as depressed mothers' children are being reared in otherwise low-risk contexts. Lewandowski and colleagues (2014) conducted a 20-year longitudinal study of depressed and non-depressed parents and identified family cohesion and easier temperament as two major resource factors for children. A child with an easier temperament, characterised by high positive affectivity, will be less adversely affected by insensitive parenting, and less likely to engage in reciprocal negativity (Downey & Coyne, 2018). Furthermore, these children may develop more advanced social skills, through attempts to gain positive attention from adults other than their depressed mother ("Maternal Depression", 2004), which could explain the seemingly superior social skills of the depressed mothers' 2-year-olds in this study.

While the strongest associations in this study were observed for maternal depression and children's social adaptive outcomes, the overall correlation results indicated no deficits in the offspring of depressed parents for any adaptive behavioural domain. Fathers' depression scores were found to be positively correlated with children's 2-year conceptual adaptive development, and mothers' 2- and 3-year depression scores were both found to positively correlate with children's overall general adaptive scores at 3 years.

As the Adaptive Behaviour scale is mother-report-based, another possible explanation for the current study's results is that mothers overestimated their children's performance. Factors such as social desirability or denial regarding the possibility of any developmental deficit in their child, can influence parents' questionnaire responses (Bornstein et al., 2015). However, in the context of the current study this is unlikely, given findings that depressed mothers tend to score their children more harshly on measures relating to their developmental capacities (Muller & Furniss, 2013). Furthermore, no developmental delays were observed in depressed mothers' children's cognitive or language functioning, the scores for which were obtained using standardised measures. This provides support for the view that the developmental outcomes of children in the current sample have not been significantly impacted by exposure to perinatal depression.

3.4.6 Conclusions

While the finding that children's social adaptive behaviour was superior among those who were exposed to antenatal depression may represent a novel finding in the literature, it is very important to consider the impact that the study's small sample size had on statistical power. Just as low power reduces the ability to detect true differences, it also substantially increases the likelihood of detecting significant spurious results, and this issue means that our findings must be interpreted with caution. Later chapters will re-examine the relationship between maternal and paternal depression with each developmental outcome, incorporating parent-child observational data. Further analyses including this data may elucidate the basis for the current study's findings and advance our understanding of the effects of perinatal depression exposure on each aspect of children's development.

Chapter 4

Parents' and children's HPA axis activity at 2 and 3 years postpartum

4.1 Introduction

According to the Developmental Origins of Health and Disease (DOHaD) hypothesis, early life experiences, occurring during critical periods of development, may significantly impact an individual's long-term health outcomes (Barker, 1990; 2007). The antenatal period is considered a critical timepoint for the origins of later developmental outcomes (Monk et al., 2019). Research has provided evidence for a significant negative association between maternal depression and children's developmental outcomes (Lawler et al., 2019). One of the key mechanisms posited to underlie this relationship is the activity of the hypothalamic-pituitary-adrenal (HPA) axis, which undergoes significant change throughout pregnancy.

4.1.1 The hypothalamic-pituitary-adrenal axis

As our primary stress response system, the HPA axis stimulates a series of physiological adjustments that aid our restoration to homeostasis (Fries et al., 2009). Exposure to a stressor triggers the release of various hormones: corticotropin-releasing hormone (CRH) and arginine vasopressin (AVP) from the paraventricular nucleus of the hypothalamus and – following secretion of these peptides into a portal blood system that goes to the pituitary gland – the secretion of adrenocorticotropic hormone (ACTH) occurs from the anterior pituitary. ACTH is released into the general blood circulation and carried to the adrenal cortex, stimulating the release of the stress hormone, cortisol (Fries et al., 2009). Cortisol binds to glucocorticoid and mineralocorticoid receptors in all tissues of the body including the brain. In the brain, cortisol attaches to receptors in the hypothalamus and the hippocampus causing a negative feedback loop, which signals a cessation to the release of CRH, and, in turn ACTH and cortisol (Fries et al., 2009). Beyond its activity associated with acute exposure to stressors, the HPA axis has a distinctive diurnal profile, with cortisol levels typically rising and peaking approximately 30-60 minutes after waking, followed by a gradual decline in levels throughout the day (de Souza-Talarico et al., 2011).

While short-term stress may have an adaptive function, chronic stress intensifies cortisol production and can disrupt the negative feedback loop of the HPA axis (Dhabhar, 2018). This alteration results in dysregulation of the stress response system (Hannibal & Bishop, 2014). HPA axis dysregulation may present in several ways, including a blunted stress response (Mazurka et al., 2016), and heightened baseline cortisol levels (Lamers et

al., 2013). HPA axis dysregulation is typically evaluated through the measurement of salivary or blood cortisol levels.

4.1.2 The HPA axis and perinatal depression

Due to the significant involvement of the HPA axis in the aetiology of depression, and its plasticity during pregnancy, the HPA axis is posited to play a major role in women's experience of perinatal depression. HPA axis activity changes significantly throughout pregnancy, primarily due to the secretion of cortisol by the placenta. During the second and third trimesters, placental CRH levels increase rapidly, which stimulates the pituitary gland, resulting in increased ACTH production and hence, increased cortisol in the pregnant woman's circulation (Mastorakos & Ilias, 2003). While a pregnant woman's circadian secretion pattern of cortisol is typically maintained until about six weeks prior to delivery, basal cortisol levels can increase by up to five times their non-pregnant level (Mastorakos & Ilias, 2003).

In contrast to the negative feedback loop that operates within the HPA axis outside of pregnancy, increased cortisol levels stimulate CRH expression in the placenta to produce more ACTH and cortisol, establishing a positive feedback loop that operates throughout the remainder of gestation (Howland et al., 2017). The foetus does not have a fully operating HPA axis until the last period of gestation due to hypothalamic immaturity, and the placental CRH maintains adequate levels of foetal cortisol needed for organ maturation. A pregnant woman's HPA axis still receives negative feedback inhibition, as increased circulating cortisol dampens hypothalamic CRH production. Hence, as term approaches, the usual stress response pathway in the HPA axis is inhibited, likely an adaptive mechanism that functions to protect both mother and foetus (Glynn et al., 2008). An additional factor that helps to mitigate foetal cortisol exposure is the placental enzyme 11β -Hydroxysteroid dehydrogenase type 2 (11β HSD-2), which converts cortisol to its inactive form, cortisone (Wyrwoll et al., 2015). High levels of maternal cortisol are required for the precipitation of the process of parturition: when cortisol levels reach a critical threshold an inflammatory process is kick-started that results in labour. Hence CRH is called the 'placental clock' (McLean et al 1995). This mechanism is of potentially critical importance in saving the life of the foetus if a pregnant woman's stress is heightened to the extent that she develops a marked cortisol stress response, possibly secondary to infection, blood loss or severe mental distress (Wood & Keller-Wood, 2016).

Antenatal depression is associated with elevated cortisol levels. O'Keane and colleagues (2011) found that depressed women in their second trimester of pregnancy displayed significantly higher CRH and evening salivary cortisol levels than non-depressed pregnant women. The authors posited that the hypersecretion of cortisol associated with antenatal depression prompts the increased production of placental CRH during early pregnancy. While cortisol is required for the maturation of foetal tissue prior to birth, overexposure may lead to dysregulated programming of the foetal HPA axis (Glover et al., 2009). Several studies have provided evidence for HPA axis dysregulation among the offspring of depressed mothers, reporting heightened stress responses from infancy (Brennan et al., 2008), through to early adulthood (Barry et al., 2015).

It is important to also examine the HPA activity of mothers postnatally. The trajectory of mothers' depressive symptoms may significantly influence their HPA axis activity throughout the perinatal period. Laurent and colleagues (2018) investigated differences in the HPA axis activity of mothers with distinct symptom trajectories at 3, 6, 12 and 18 months postpartum. Depressed mothers whose symptoms worsened across the perinatal period displayed an elevated, unremitting cortisol response profile compared to mothers whose depression did not worsen during this time. The authors suggested that for mothers with chronic perinatal depression, a trajectory of increasing severity may both arise from and incur stress response hyperactivation (Laurent et al., 2018). Seth and colleagues' (2016) systematic review reported that some evidence suggests the existence of a significant association between hypercortisolism and antenatal depression, while hypocortisolism seems to be linked to chronic postnatal depression. However, a lack of consistency in the measures used across studies and the predominant use of cross-sectional design, have limited the certainty associated with the strength of these associations.

4.1.3 The cortisol awakening response and perinatal depression

One of the primary indices used to evaluate HPA activity is the cortisol awakening response (CAR). The CAR constitutes an individual's physiological response to awakening, and is considered a relatively stable measure, which has led to its prevalent use in research examining HPA axis activity (Wilhelm et al., 2007).

In most individuals, cortisol levels peak approximately 30 minutes after awakening, decrease 60 minutes after awakening, and gradually decline throughout the day (de Souza-Talarico et al., 2011). In healthy adults, the magnitude of peak increase

may range from 50% to over 100% of their baseline cortisol level (Clow et al., 2010). Some studies have found a higher CAR among women compared to men (Pruessner et al., 1997; Wüst et al., 2000), while other studies reported no significant difference (Edwards et al., 2001; Kudielka & Kirschbaum, 2003). An association between older age and a lower CAR has also been reported in some studies (Kudielka & Kirschbaum, 2003), while others have found no such link (Polk et al., 2005; Pruessner et al., 1997).

Research examining patients with clinical depression diagnoses has reported associations between depression and atypical CARs. In Vreeburg et al.'s (2009) study, middle-aged depressed participants had a significantly higher mean CAR than healthy controls. A similar positive association between depression and the CAR has been reported in samples of depressed adolescent females (Ulrike et al., 2013) and young adult women (Dienes et al., 2013). However, other studies have reported a blunted CAR among young adult women with clinical depression, ranging from mild to moderate in severity (Stetler & Miller, 2005), as well as a significantly flatter CAR in depressed patients compared to patients with other psychiatric diagnoses (Huber et al., 2006). A previous REDEEM group study found that while the cortisol levels of depressed participants were higher upon awakening, the CAR was blunted (Doolin et al., 2017).

Several studies have also provided evidence for the effect of depression on the CAR in cases where symptoms are subclinical. For example, Dedovic and colleagues (2010) examined cortisol levels in three groups of young adults – controls, moderate and high subclinical depressive symptoms – and reported a significantly flatter CAR among the high subclinical participants (Dedovic et al., 2010). Mangold and colleagues (2011) also reported a flatter CAR among 18-38-year-old adults who had high subclinical symptoms compared to those with low and moderate subclinical symptoms (Mangold et al., 2011). This attenuated CAR was significantly associated with depressive symptomatology over and above previous history of emotional abuse, sexual abuse, and physical punishment (Mangold et al., 2011).

The CAR has also been examined in individuals with a history of depression. In Vreeburg et al.'s (2009) large cohort study, both participants with current MDD and those in remission had higher CARs compared to euthymic participants with no history of depression. Similar results for elevated CARs among individuals with a history of depression were reported by Bhagwagar and colleagues (2003) and Aubry et al. (2010), while Mannie and colleagues (2007) also observed higher CARs in 17-21-year-old non-depressed participants, with a familial risk of depression, compared to their peers with no

family history of depression (Mannie et al., 2007). Taken together, it seems that the impact of current or previous depression on HPA activity can be observed through abnormalities in an individual's CAR, even among patients whose depressive symptoms are subclinical.

Most research that has examined CAR in relation to perinatal depression has focused on the antenatal or early postnatal period. Two systematic reviews (Seth et al., 2016; Orta et al., 2018) reported that women with antenatal depression, as measured during their second or third trimester, displayed elevated CAR compared to non-depressed pregnant women. Conversely, some studies have reported reduced CAR in pregnant women with clinical depression diagnoses (Szpunar & Parry, 2018). O'Connor and colleagues (2014) also reported significantly lower CAR among pregnant women with clinical depression compared to non-depressed pregnant women. However, their overall cortisol output throughout the day was elevated compared to controls.

The literature examining CAR in the postnatal period has also produced mixed findings. Taylor and colleagues (2009) reported a reduced mean CAR in depressed women at 7 weeks postpartum, while other studies reported no significant relationship between CARs and women's depression at 4-6 weeks postpartum (Cheng & Pickler, 2010) or the CAR and antenatal depression (Cheng & Pickler, 2010; Pluess et al., 2010). Contrasting cortisol profiles among depressed women in the antenatal versus postnatal period have been proposed to arise from the major change in cortisol, from the substantially elevated level during pregnancy to a rapidly decreased level postpartum (O'Keane et al., 2011). To our knowledge, no previous research has examined the relationship between perinatal depression and CAR beyond the first twelve months postpartum. Hence, further longitudinal research is required to examine mothers' postnatal HPA activity over a longer period.

4.1.4 Exposure to perinatal depression and children's HPA axis activity

Early research examining young children's HPA axis activity was predominantly carried out in their home environments and by taking once-off cortisol samples. However, more recent research has furthered our understanding of children's HPA activity in relation to their cortisol reactivity. This has been achieved through the use of controlled laboratory conditions to evaluate acute stress responses (Gunnar et al., 2009; Puhakka & Peltola, 2020). A cortisol response peaks approximately 20 minutes following exposure to a

stressor, and typically returns to baseline during the following 20-30 minutes (Gunnar & Quevedo, 2007).

Most studies that have examined the HPA activity of depressed mothers' infants have reported increased activity, as indicated by elevated basal cortisol levels and heightened stress responses (Brennan et al., 2008; Luecken et al., 2013). Brennan and colleagues (2008) reported significant associations between antenatal and postnatal depression, and 6-month-old infants' baseline cortisol, alongside greater reactivity to laboratory stressors. This association has also been observed in older children who were exposed to maternal perinatal depression. For example, Ashman and colleagues (2002) found a significant positive association between maternal perinatal depression during the first two years postpartum and children's baseline cortisol levels at 7 years of age. This link between perinatal depression and elevated offspring cortisol has been observed in adolescents and young adults; studies have reported significantly higher morning cortisol (Halligan et al., 2004) as well as heightened reactivity to a social stress task, compared to individuals whose mothers did not experience perinatal depression (Barry et al., 2015).

While stress reactivity research has primarily examined infants, older children and adolescents (Halligan et al., 2004; Puhakka et al., 2020), the literature examining perinatal depression and stress reactivity in toddlers has expanded in recent years, and produced mixed findings (Lucci et al., 2016; Swales et al., 2018). Gunnar and Vazquez (2001) reported a significant association between maternal postnatal depression and toddlers' flattened diurnal cortisol profiles. However, other studies reported a link between maternal current depression and toddlers' heightened cortisol reactivity (Dougherty et al., 2011; Dougherty et al., 2013). Studies that have examined both antenatal and postnatal maternal cortisol in relation to offspring HPA activity have provided support for a stronger influence of antenatal cortisol on children's subsequent HPA axis activity. Grant and colleagues (2009) reported a significant link between antenatal cortisol and infants' stress reactivity at 7 months postpartum, and no significant association between mothers' postnatal cortisol and offspring reactivity. Furthermore, Swales and colleagues (2018) reported a significant association between maternal depression severity during the first trimester and children's elevated stress reactivity at 3 years of age, providing further support for the significant foetal HPA axis programming that occurs from early pregnancy.

Another study that examined the relationship between toddlers' stress reactivity and their exposure to heightened antenatal cortisol was conducted by Yong Ping and

colleagues (2015). This study examined stress responses in toddlers who had been exposed to elevated antenatal stress as a result of a major flood. While perinatal depression was not examined specifically, Yong Ping et al.'s (2015) finding – that toddlers whose mothers had experienced heightened antenatal stress exhibited a greater cortisol response to a mother-toddler separation test relative to those whose mothers had not experienced abnormal antenatal stress – supports the view that children's antenatal exposure to heightened cortisol can result in subsequent hyperreactivity to a stressor. Overall, these findings indicate that heightened cortisol exposure in utero, and the programming influence associated with antenatal depression, may play a greater role in offspring HPA axis development, relative to postnatal depression. Further longitudinal research is required to elucidate the possible differential and combined effects that women's experiences of depression both antenatally and postnatally may have on children's current and subsequent HPA axis activity.

4.1.5 Children's HPA axis activity and their developmental outcomes

Maternal depression is associated with poorer offspring outcomes, particularly in the social-emotional domain (Goodman et al., 2011). While many studies have provided evidence to support this link, less is known about the mediators in the relationship between children's exposure to maternal depression and children's subsequent outcomes (Lawler et al., 2019). One proposed mechanism underlying children's increased risk of experiencing poorer outcomes lies in the development of their stress response systems. Maternal postnatal depression has been linked to children's altered HPA axis activity (Dougherty et al., 2013), which has consequently been associated with children's behavioural issues (Van den Bergh et al., 2008).

Studies examining the relationship between altered HPA axis activity and children's social-emotional outcomes have primarily focused on their internalising (e.g. depression and anxiety) and externalising (e.g. aggression, impulsiveness) symptoms. While altered HPA activity has been linked to children's heightened risk of internalising and externalising disorders, studies have provided inconsistent evidence for the direction of this effect. While some studies identified infants' higher baseline cortisol (Brummelte et al., 2011) and toddlers' stress hyperreactivity (Bagner et al., 2010) as significant predictors of subsequent internalising and externalising symptoms, others reported that hypocortisolism, including a flattened diurnal slope (Gunnar & Vazquez, 2001; Laurent et al., 2013) and blunted stress responses (van Goozen et al., 1998) predicted more offspring

issues. It has also been suggested that increased cortisol levels may be associated with greater internalising issues, while decreased cortisol levels, as indicated by blunted stress responses (van Goozen et al., 1998) and lower baseline cortisol (Shirtcliff et al., 2005), may be linked to children's externalising issues. However, internalising and externalising symptoms are often comorbid among children who have experienced early life adversity, which has led researchers to question this posited dichotomy of cortisol profiles and how they relate to distinct social-emotional issues (Lawler et al., 2019).

The age at which children are examined may represent another important factor underlying associations between children's stress reactivity and behavioural issues. Alink et al.'s (2008) meta-analysis found that externalising issues were associated with higher basal cortisol in preschool-aged children, but lower basal cortisol in primary school-aged children. Furthermore, other researchers have proposed that hyperreactivity during early childhood may result in down-regulation of the HPA axis in later childhood and adolescence (Gunnar & Vazquez, 2001; Gustafsson et al., 2010). Hence, there may be a non-linear relationship between HPA activity and children's development, wherein either abnormally high or low cortisol levels can be indicative of adverse outcomes (Doom & Gunnar, 2013).

Few studies have investigated the mediating effect of HPA activity on the relationship between exposure to perinatal depression and subsequent offspring outcomes, and the majority that have examined this effect have focused on functioning during childhood or adolescence. For example, in Apter-Levi and colleagues' (2016) longitudinal study, maternal postnatal depression was found to predict blunted stress responses, which were associated with increased psychopathology and social withdrawal among 6-year-old children. Additionally, Halligan et al. (2007) reported that offspring morning cortisol levels at 13 years mediated the effect of maternal depression on offspring self-reported depression at 16 years of age.

To the author's knowledge, only one longitudinal study, conducted by Lawler and colleagues (2019) has examined altered HPA axis activity in 6-month-old infants and their subsequent social-emotional outcomes at 18 months postpartum. In this study, an unexpected pattern of infant cortisol reactivity was observed, in which mean cortisol levels declined from baseline through to post-stressor, and then increased at subsequent timepoints. Lawler et al. (2019) found that the abnormal U-shaped cortisol pattern was most apparent in offspring whose mothers had severe depression and was significantly associated with 18-month-olds' behavioural issues. Conversely, children whose mothers

had mild depression displayed the expected cortisol reactivity pattern, with an increase following exposure to the stressor, succeeded by a recovery to baseline levels of cortisol. Taken together, these findings suggest that children whose mothers have mild depression may display typical stress reactivity, as is usually observed in children of non-depressed mothers, whereas children whose mothers have more severe current or previous depression may display abnormal HPA axis activity when faced with a stressor.

The literature examining children's HPA axis activity and cognitive outcomes has provided evidence for an inverted U-shaped relationship between cortisol and cognitive functioning. Moderate levels of cortisol appear to facilitate enhanced cognitive performance, while chronically low or high levels may adversely affect neural structures, and result in cognitive impairments, including attention and memory issues (Erickson & Barnes, 2003). This association between abnormally high or low cortisol levels and lower cognitive functioning has been reported in studies examining 15-month-old infants (Finegood et al., 2017) and 4-year-old children (Suor et al., 2015).

Children's development of higher-order cognitive skills – executive function (EF) – has been a key focus in research examining the relationship between HPA axis activity and children's outcomes. The literature has provided evidence for a significant association between children's HPA axis activity and their EF abilities (Perry et al., 2018). Moderate baseline cortisol is considered the optimal level for regulating cognition, as sufficient arousal is evoked to facilitate an individual's preparation for, and response to, challenges (Arnsten, 2009; Perry et al., 2018). However, hyper- or hypoarousal of children's stress systems, as indicated by significantly lower or higher cortisol levels, have both been linked to EF deficits (Blair et al., 2017; Braren et al., 2020; Suor et al., 2015). Taken together, it seems that a moderate level of cortisol is associated with children's superior EF outcomes.

4.1.6 Fathers' role in children's HPA activity

Due to the intrinsic link between mothers' and children's HPA axes, research has primarily focused on this relationship when considering the physiological influence of parents on children's basal cortisol and stress reactivity (Lawler et al., 2019). However, due to increased interest in the importance of paternal involvement in child development, researchers have begun to investigate the influence that fathers may have on children's HPA axis development. Paternal depression and negative parenting behaviours have been consistently associated with adverse offspring outcomes (Gross et al., 2008; Ramchandani

et al., 2005; Ramchandani et al., 2008). However, the neurobiological mechanisms that may underlie these associations have received relatively little attention. Nevertheless, existing evidence indicates that fathers may play a significant role in their children's HPA axis activity across several developmental stages.

During infancy, fathers may have a significant influence on infants' HPA axis development, through the support provided to mothers. Women who report greater relationship satisfaction have been found to have superior physiological attunement with their infants than mothers who report low satisfaction (Clauss et al., 2018). Hibel and colleagues (2018) also found that infants whose mothers had more cohesive relationships with their infant's father displayed greater recovery following exposure to a stressor. As children develop, fathers may have a more direct effect on their HPA axis activity, through increased involvement in caregiving. Supportive fathers who engage in frequent positive interactions with their children provide a sense of stability, while also presenting opportunities for them to learn to self-regulate emotional and physiological responses (Denham, 2007), particularly through the 'rough and tumble' style of play that fathers tend to engage in (Amodia-Bidakowska et al., 2020). Evidence for the protective role that fathers can play in their children's HPA axis activity throughout adolescence and young adulthood has been provided; Ibrahim and colleagues (2017) found that young adults who reported engaging in frequent shared activities with their fathers during adolescence had significantly lower cortisol reactivity to social stressors.

Studies examining fathers' engagement in negative parenting behaviours have provided further evidence for the significant influence that fathers can have on children's HPA axis activity. For example, Mills-Koonce and colleagues (2011) reported a significant link between fathers' negative parenting behaviours and their children's increased cortisol reactivity during infancy, as well as heightened cortisol levels during toddlerhood. Boyce et al.'s (2006) longitudinal study of parenting behaviours and children's outcomes found that a combination of low paternal involvement during infancy and increased cortisol reactivity at the age of 7 was predictive of increased internalising symptoms at 9 years of age (Boyce et al., 2006). Furthermore, this effect was independent of maternal depression. Taken together, current evidence supports the view that fathers' early parenting quality may uniquely influence children's HPA axis activity and subsequent outcomes.

4.1.7 Study outline

While the literature examining HPA axis activity among parents and their children has expanded in recent years, several uncertainties remain. First, it is not clear whether high subclinical, as opposed to clinical perinatal depression may have a significant impact on children's HPA axis activity and subsequent outcomes. Furthermore, most research that has examined the effect of offspring HPA axis activity on the relationship between maternal depression and children's subsequent outcomes has done so with infants. Further research is required to examine whether a similar mediating effect is at play for children's outcomes measured during toddlerhood. Furthermore, to our knowledge, no previous research has examined children's adaptive behaviour as a distinct developmental domain. In the study outlined in Chapter 3, the offspring of mothers who had antenatal or current depression were found to obtain significantly higher adaptive behaviour scores than children of non-depressed mothers, posited to be a potential indicator of resilience among the children who had been exposed to maternal depression. Examination of mothers' and children's HPA axis activity may partially elucidate the basis for this finding.

Finally, only one previous study, conducted by Lawler and colleagues (2019), examined mothers' and children's HPA axis activity across the perinatal period. However, Lawler et al.'s final timepoint was 18 months postpartum. Furthermore, both parents have the potential to shape offspring HPA axis development into early childhood. Hence, the relationship between mothers', fathers' and children's HPA activity requires investigation over a longer period. The current study will examine associations between maternal antenatal and postnatal HPA axis activity, paternal postnatal HPA axis activity, children's cortisol and developmental outcomes at 2 and 3 years postpartum. Based on prevalent findings in the literature the following hypotheses were formed:

Hypothesis 1: Parents' depression and their HPA axis activity

Due to the widely reported association between current or remitted depression and atypical HPA axis activity, we predicted that there would be significant group differences between the Control, History of depression and Depressed groups for mothers' HPA axis activity, as measured by Cortisol Awakening Response (CAR) at the 2- and 3-year timepoints. Based on the REDEEM group's previous findings in relation to depressed individuals' HPA axis activity (Doolin et al., 2017), it was hypothesised that parents' higher depression scores would be associated with elevated baseline cortisol, and blunted CARs at 2 and 3 years.

Hypothesis 2: Parents' depression and children's HPA axis activity

We hypothesised that children of depressed mothers would display higher resting cortisol levels compared to children of non-depressed mothers. Furthermore, we predicted that children whose mothers had higher current depression scores would display heightened stress reactivity.

Hypothesis 3: Children's HPA axis activity and their social-emotional outcomes

Due to the lack of consensus within the literature, regarding the cortisol profile that typically reflects SE issues, we hypothesised that significantly altered, either lower or higher basal cortisol levels, would be associated with children's lower SE scores at 2 and 3 years of age. While some researchers have proposed links between distinct cortisol profiles and differing SE issues – particularly hypocortisolism and increased internalising, and hypercortisolism and increased externalising – other researchers have reported an association between heightened cortisol and increased levels of both (Bagner et al 2010). Furthermore, internalising and externalising symptoms are often comorbid. Hence, the current study examined social-emotional development overall, through evaluation of children's BSID-III composite scores, which represented their overall SE adjustment.

Hypothesis 4: HPA axis activity and cognitive, EF, language and adaptive outcomes

In line with several studies of children's HPA axis activity, cognitive and EF outcomes (e.g. Blair et al., 2017; Braren et al., 2020; Suor et al., 2015), we predicted that moderate levels of resting and pre-stressor cortisol, would be positively related to children's cognitive, EF and language scores. We hypothesised that either hypo- or hyperarousal, as indicated by significantly lower or higher cortisol levels, would be associated with children's lower developmental scores. To the author's knowledge, no previous research has examined the relationship between children's HPA axis activity and their adaptive behavioural development. As this domain evaluates a child's ability to navigate their environment independently and is significantly correlated with children's cognitive outcomes, we hypothesised that abnormalities in children's cortisol levels would also be negatively associated with children's adaptive behaviour scores.

4.2 Method

4.2.1 Participants

Participants were recruited through perinatal psychiatry services and antenatal booking clinics during their second or third trimester of pregnancy. Women who met the study's inclusion criteria were assessed by a research registrar in Psychiatry, who stratified participants into three groups: Depressed, History of Depression and Control. At the 2- and 3-year timepoints, available fathers also participated in the study. Demographic information on the sample is provided in Chapter 2, Section 2.2.3. At the 2-year timepoint, 49 mothers and 35 fathers provided saliva samples, of which 40 and 32, respectively, contained a sufficient amount of saliva for cortisol analyses. The 2-year analysis of offspring HPA activity was based on 25 children. At 3 years, 15 fathers were available to attend the follow-up appointment in-person, but an additional 10 fathers provided their saliva samples via post. Hence, at the 3-year timepoint, cortisol analyses were based on samples provided by 35 mothers, 25 fathers and 38 children. The number of participants per group whose samples were included in the current study's analyses are displayed in Table 4.1.

Table 4.1

The number of participants whose samples were included in cortisol analyses at 2 and 3 years.

	Control			History			Depressed		
	M	F	C	M	F	C	M	F	C
2 years	19	15	14	14	11	8	7	7	3
3 years	18	13	19	16	8	14	4	4	5

Note. M = Mothers; F = Fathers; C = Children.

4.2.2 Measures

Parental clinical measures

Interviews based on the Hamilton Rating Scale for Depression (HAM-D; Hamilton, 1960) were conducted at the study's first timepoint with mothers by O'Leary et al. (2018), and at 2 and 3 years with both parents, to evaluate all participants' current depression severity

levels. Both parents also completed self-report mood-related questionnaires: the Center for Epidemiologic Studies: Depression Scale (CES-D; Radloff, 1977) and the Perceived Stress Scale (PSS; Cohen et al., 1983) at 2 and 3 years postpartum.

Child developmental measures

Bayley Scales of Infant Development-3rd Edition (BSID-III; Bayley, 2006)

At the 2-year timepoint, the Cognitive and Language scales of the BSID-III were administered, while only the language scales were administered at the 3-year timepoint. Children's raw scores were scaled and converted to composite scores, which were used to represent children's developmental outcomes in the current study's analyses.

Bayley-III Social-Emotional Scale (Greenspan, 2004)

The raw and scale scores obtained from a 35-item mother-report questionnaire, designed to evaluate a child's social-emotional development, were summed and converted to scores. These scores were used to assess children's social-emotional outcomes.

Executive Function

At the 3-year timepoint, five tasks designed to assess children's Executive Function (EF) ability, were administered. Total scores were tallied to produce an overall composite score for EF. Further details of this measure were provided in Chapter 2, Section 2.3.4.

Laboratory stressors

At the 2-year timepoint, children were presented with a scenario designed to evoke a stress response. The child was given a challenging locks toy, designed for use by older children, while the mother and researcher remained in the room, but did not interact with them. The toy board, which had six locked doors to be opened, was acquired from the TCD Infant and Child Research Laboratory's mastery task protocol for 2-year-olds. This toy was selected based on Morgan et al.'s (1992) 'Individualised assessment for mastery motivation' guidelines, which advise the use of goal-oriented toys that are challenging for a child's developmental level.

The board was placed on the play-mat in the lab, and after the researcher had modelled the opening of one lock, and the child had attended to the board, a 3-minute timer was started. The researcher and mother sat on opposite sides of the room, not interacting with each other or the child. This aspect of the stressor was adapted from the

Toddler Still-Face (T S-F) paradigm (Weinberg et al., 2008), which was designed to evaluate young children's ability to self-regulate when faced with a stressor. Like the original T S-F, the current study's stressful situation followed normal mother-child play and preceded further mother-child play. Prior to initiating the stressor, the researcher explained to the mother that the task was intended to be frustrating for the child, and that they would be able to assist them in completing the board after the 3 minutes had elapsed. No child successfully opened more than four of the six locks on the board.

At the 3-year timepoint, a modified version of the Strange Situation (Ainsworth et al., 1978) was used to evoke stress. Mothers were informed about the upcoming interaction prior to initiating the stressor. First, mother and child engaged in free play for 10 minutes, and then without warning to the child, the mother left the room and a research assistant (the stranger) who the child had not seen before, entered and sat down on the mat. As the toys from the mother-child interaction were still present, the stranger attempted to initiate play with the child. Meanwhile, the mother and researcher watched the encounter from the adjacent observation room. The interaction was timed for 3 minutes, and like the traditional Strange Situation protocol was followed by a reunion interaction with the child's mother.

4.2.3 Biological measures

Parental salivary cortisol

Prior to their appointment in the TCD Infant and Child Research Laboratory, information packs were sent to families, including confirmation of their appointment, and two saliva kits, containing Sarstedt Salivette™ swabs, labelled by time after waking. Parents were asked to collect saliva samples at three points across one morning of the same day: the first, upon waking (0 minutes), and again 30 and 60 minutes after waking. To avoid measurement error, participants were asked to avoid eating, drinking or brushing their teeth for at least 30 minutes prior to collection. They were also instructed to collect their samples one day prior to their lab appointment, and to refrigerate their swabs until the time came to leave, in order to minimise the amount of time the samples were kept at room temperature. Upon arrival to their lab appointment, participants' samples were collected and refrigerated.

Children's salivary cortisol

Three saliva samples were obtained from children during the course of their appointment in the Infant and Child Research Laboratory, using Salimetrics SalivaBio children's swabs. The first sample was collected within 15 minutes of the family's arrival to the lab and served as a measure of their baseline cortisol level. The second sample was taken prior to the presentation of a stressor, and the third was collected 30 minutes later.

Cortisol analyses

Immediately after the appointment, parents' and children's swabs were centrifuged at 3500 rpm at 20°C for 15 minutes. Saliva samples were pipetted into microtubes and stored in a -80°C freezer in Trinity College Institute of Neuroscience on the TCD campus. Frozen samples were sent in batch on dry ice to Dr. Gerard Boran's laboratory at Tallaght University Hospital, Dublin for analysis. Salivary cortisol concentrations were measured using the Elecsys® Cortisol II immunoassay, which has a lower limit of detection for cortisol of <1.5 nmol/L (Roche Diagnostics, 2020). To minimise error in estimating true cortisol values, values of 1.5 were replaced with the value of the lower limit of detection, divided by the square root of 2, resulting in a value of 1.06 (Croghan, 2003). Prior to statistical analysis, the cortisol data were screened for outliers; any values greater than 3 standard deviations above or below the mean were omitted. At 2 years, this resulted in the removal of one value from a mother in the Control group, and from one child in the Control group. At three years, the removal of outliers included one mother in the Control group, one mother in the History group, and one father in the History group.

The current study's primary parental indices of interest were baseline cortisol and the cortisol awakening response (CAR). The CAR was measured by calculating the area under the curve with respect to increase (AUC_i), for each participant. The AUC_i is a variable that encapsulates the AUC with respect to increase, from baseline through to later timepoints, and emphasises the change in cortisol over time. The AUC_i was computed for each participant using formulae outlined by Fekedulegn et al. (2007). Parental baseline cortisol was also calculated, by averaging the cortisol values obtained from parents' 0-, 30- and 60-minute saliva samples.

Children's baseline cortisol levels were measured in the first saliva sample obtained during the lab appointment. Their stress reactivity was evaluated by calculating AUC_i, as well as the area under the curve with respect to ground (AUC_g). AUC_g takes into account the distance from zero and represents the total area under the curve for all

cortisol measurements (baseline, pre- and post-stressor). AUCg reflects the difference between each measurement from each other, as well as the intensity, as indicated by their distance from the ground (Fekedulegn et al., 2007).

4.2.4 Statistical analyses

All data were analysed using SPSS (Version 26, IBM). Normality was assessed using QQ plots and Shapiro-Wilks tests. Due to a lack of normality across the cortisol variables, all values were log transformed. As log transformations can only be carried out for positive values, above zero, negative Area Under the Curve with respect to increase (AUCi) values were transformed by adding a constant to all parental AUCi values. While further analyses were run on transformed variables, descriptive data are presented in the original units for cortisol concentration, nanomole per litre (nmol/L).

The first hypothesis predicted that there would be significant group differences in mothers' CAR, and that parents' depression scores would be associated with higher baseline cortisol and blunted CAR at 2 and 3 years. Due to uneven group sizes and heterogeneity of variance, nonparametric Kruskal-Wallis tests were conducted to examine group differences in CAR, as indicated by AUCi. Post-hoc Bonferroni tests were conducted to correct for multiple comparisons. A nonparametric repeated measures Friedman test was used to examine continuity among mothers' and fathers' cortisol levels from 2 to 3 years. Spearman rank-based tests examined cortisol covariation among mothers, fathers and children, as well as associations among parents' cortisol and their mood scores (HAM-D, CESD and PSS).

The second hypothesis predicted that children's resting cortisol would be associated with mothers' antenatal depression, and that children's stress reactivity would be associated with mothers' higher current depression scores. First, in order to assess whether the stressor paradigms used in the study evoked a significant stress response among children, paired-sample t-tests were conducted. In order to examine group differences in children's basal cortisol, Kruskal-Wallis tests with Bonferroni corrections were conducted. Spearman rank-based tests were conducted to examine associations between parents' current depression scores and children's basal cortisol and stress reactivity, as indicated by AUCi and AUCg. Due to a lack of normality, nonparametric Mann-Whitney U tests were used to examine gender differences in children's basal cortisol and stress reactivity.

In order to examine the third hypothesis – that children’s significantly altered (either lower or higher) basal cortisol would be associated with lower SE scores – Tukey’s median-based hinges were used to categorise cortisol values and social-emotional scores into the 25th, 50th and 75th percentiles for the current sample. The ‘lower hinge’ represents the 25th percentile, the ‘mid-hinge’ is the 50th percentile (the median) and the ‘upper hinge’ is the 75th percentile. Kruskal-Wallis tests were conducted to ascertain whether the differences in cortisol output at each of these percentiles were statistically significant, and that the difference in SE scores at each hinge was also statistically significant. Further Kruskal-Wallis tests and Bonferroni corrections were conducted to examine whether there was a significant difference in the SE scores of children whose cortisol output fell at the sample’s 25th percentile compared to children whose cortisol fell at the sample’s 75th percentile.

In order to examine the fourth hypothesis, which predicted that children’s significantly lower or higher cortisol levels would be associated with lower cognitive, language and adaptive scores, Tukey’s median-based hinges were used to categorise children’s developmental scores into percentiles. Differences in children’s basal cortisol and stress reactivity among these cognitive, language and adaptive percentile groups were examined using Kruskal-Wallis tests and Bonferroni corrections. Mothers’ and fathers’ CAR percentiles were also computed using Tukey’s hinges and Kruskal-Wallis tests were used to examine differences in the cognitive, language and adaptive outcomes of children whose parents fell at each percentile examined.

4.3 Results

4.3.1 Perinatal depression and parents’ HPA axis activity

Descriptive data for parents’ salivary cortisol levels are provided in Table 4.2. As the data were non-normally distributed, this table provides Median (Mdn) and Interquartile Range (IQR) values. While further analyses were based on log-transformed values, descriptive cortisol data are presented in their original units, nanomoles per litre (nmol/L). Kruskal-Wallis tests indicated that there were no significant group differences in parents’ baseline cortisol levels or their CAR, as indicated by the Area under the curve with respect to increase (AUC_i), at 2 or 3 years postpartum. At 2 years, the observed power of the Kruskal-Wallis tests conducted was estimated at 31.4% for mothers’ CAR and 26.5% for fathers’ CAR. At 3 years, observed power was estimated at 26.5% for maternal CAR and

23.5% for paternal CAR. Mothers' and fathers' median cortisol levels measured upon awakening (0 minutes), 30 and 60 minutes later, at the 2-year timepoint, are displayed in Figures 4.1 and 4.2. A non-parametric repeated measures Friedman test indicated that there was continuity in mothers' and fathers' cortisol output, from the 2- to 3-year timepoint, with no significant differences observed among mothers' or fathers' cortisol from one timepoint to the next.

Table 4.2

Descriptive data for parents' HPA axis activity at 2 and 3 years.

		Control		History		Depressed	
Variable		Mdn	IQR	Mdn	IQR	Mdn	IQR
2 years	M baseline	9.07	6.42	11.59	5.98	13.11	12.03
	M AUCi	14.39	8.16	11.39	8.58	16.62	9.24
	F baseline	10.81	10.07	9.36	6.37	11.52	9.61
	F AUCi	9.25	4.80	8.12	9.14	11.06	5.75
3 years	M baseline	12.94	5.49	11.52	9.22	14.41	12.27
	M AUCi	12.10	8.78	11.30	9.26	15.65	7.17
	F baseline	7.99	5.84	10.38	11.91	12.15	12.91
	F AUCi	7.82	4.39	8.45	8.50	11.33	9.13

Note. M = Mother; F = Father; AUCi = Area under the curve with respect to increase.

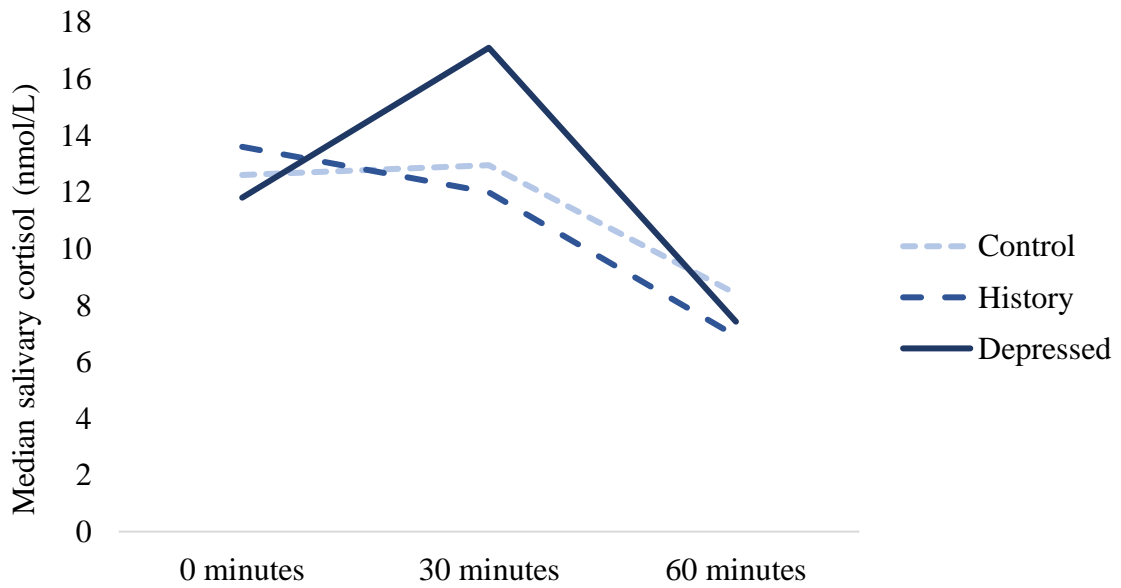


Figure 4.1. Mothers' median salivary cortisol levels upon awakening (0 minutes), 30 and 60 minutes later, in each participant group at 2 years postpartum.

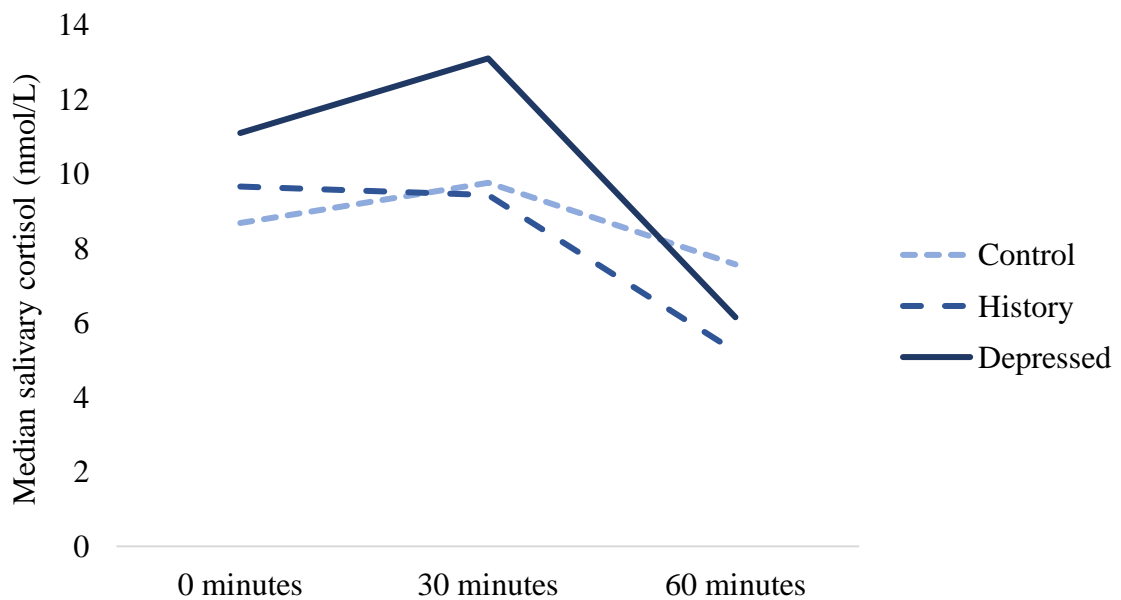


Figure 4.2. Fathers' median salivary cortisol levels upon awakening (0 minutes), 30 and 60 minutes later at 2 years postpartum, based on their partners' antenatal grouping.

Spearman rank-based tests indicated a positive correlation between mothers' antenatal and 2-year baseline cortisol levels ($r_s = .411, p < .05$, observed power = 72.3%), and no significant correlation between mothers' antenatal and 3-year baseline cortisol ($r_s = .214, p = .812$, observed power = 23.5%). Mothers' and fathers' baseline cortisol levels were positively correlated at both 2 ($r_s = .653, p < .01$, observed power = 85.8%) and 3 years ($r_s = .467, p < .01$, observed power = 61.6%). A moderate positive correlation was found for fathers' 3-year baseline cortisol and their perceived stress scores, ($r_s = .529, p < .05$, observed power = 72.3%) and there was a strong negative correlation between fathers' 3-year CAR and their concurrent HAM-D scores ($r_s = -.673, p < .01$, observed power = 44.5%). There were no other statistically significant associations between mothers' or fathers' current HAM-D scores and their HPA axis activity at 2 or 3 years.

Spearman tests were also used to examine associations between parents' and children's concurrent HPA axis activity. Correlations for parents' and children's HPA axis activity at 2 and 3 years are displayed in Table 4.3 and Table 4.4 respectively. The observed power estimated for the significant associations found between children's baseline cortisol and stress reactivity at 2 and 3 years was 85.3% and 92.6% respectively.

Table 4.3*Spearman correlation coefficients for parents' and children's HPA axis activity at 2 years.*

Cortisol variable	1	2	3	4	5	6	7	8
1. M antenatal baseline	1							
2. M antenatal AUCi	.102	1						
3. M 2-year baseline	.411*	.232	1					
4. M 2-year AUCi	.275	-.002	.077	1				
5. F 2-year baseline	.311	.054	.653**	.265	1			
6. F 2-year AUCi	-.351	.422	-.115	-.189	-.185	1		
7. 2-year-olds' basal cortisol	-.073	-.328	.192	.149	.391	-.227	1	
8. 2-year-olds' AUCi	.267	.301	-.412	-.181	-.345	.030	-.792**	1

Note. M = Mother; F = Father; AUCi = Area under the curve with respect to increase; * $p < .05$; ** $p < .01$.

Table 4.4*Spearman correlation coefficients for parents' and children's HPA axis activity at 3 years.*

Cortisol variable	1	2	3	4	5	6
1. Mothers' baseline cortisol	1					
2. Mothers' AUCi	-.138	1				
3. Fathers' baseline cortisol	.326	.408	1			
4. Fathers' AUCi	-.098	-.323	-.296	1		
5. Children's basal cortisol	-.138	.451*	.058	.263	1	
6. Children's AUCi	.014	-.381*	-.049	-.348	-.788**	1

Note. AUCi = Area under the curve with respect to increase; * $p < .05$; ** $p < .01$.

4.3.2 Perinatal depression and children's HPA axis activity

The overall median baseline cortisol for 2-year-old offspring was 3.34 nmol/L (IQR = 3.78), while children's median baseline cortisol at 3 years was 2.63 nmol/L (IQR = 3.37). These values lie within the normative range for children of this age; Rolfsjord et al. (2017) reported morning salivary cortisol ranging from 2.5 to 189 nmol/L at 2 years.

Descriptive data for children's salivary cortisol by participant group are provided in their original units (nmol/L) in Table 4.5. Kruskal-Wallis tests were used to detect group differences in children's basal cortisol levels and their stress reactivity, as measured by AUCg and AUCi. No significant differences were found for either children's baseline cortisol or reactivity, at 2 or 3 years postpartum. Spearman rank-based correlations indicated no significant associations between parents' current depression scores and children's basal cortisol or stress reactivity. Mann-Whitney U tests were used to assess gender differences in HPA axis activity, the results of which indicated no significant differences between male and female offspring in their basal cortisol or reactivity at either timepoint.

Table 4.5*Descriptive data for children's HPA axis activity at 2 and 3 years.*

Timepoint	Variable	Control		History		Depressed	
		Mdn	IQR	Mdn	IQR	Mdn	IQR
2 years	Basal cortisol	3.07	1.48	2.96	7.58	4.38	9.25
	Pre-stressor	2.65	2.97	3.56	4.08	3.24	4.76
	Post-stressor	3.15	4.36	4.25	3.42	4.16	9.11
	AUCi	1.47	5.16	2.44	7.45	3.04	1.97
3 years	Basal cortisol	2.58	3.65	3.09	2.02	1.81	3.28
	Pre-stressor	2.22	2.27	2.42	2.46	2.21	4.38
	Post-stressor	3.20	2.31	2.79	3.98	4.17	7.16
	AUCi	3.37	6.69	4.56	4.84	4.69	5.75

Note. AUCi = Area under the curve with respect to increase.

4.3.3 Children's reactivity to stressors

Paired-samples t-tests were conducted to assess whether the stressor paradigms used at the 2- and 3-year timepoints evoked a significant stress response among children. At 2 years, there was no significant difference in children's cortisol levels before and after their exposure to the stressor, $t(24) = -1.47$, $p = .16$, $d = .32$. The observed power in this test was 37.8%. At 3 years, there was a significant change in children's pre- ($M = .35$, $SD = .28$) and post-stressor ($M = .47$, $SD = .36$) cortisol levels, $t(36) = 2.15$, $p = .03$, $d = .38$, which indicates that the 3-year stressor generally evoked a significant stress response. The observed power in this test was 60.5%. Kruskal-Wallis tests examining children's Area under the curve with respect to ground (AUCg) indicated that there was no significant difference in the reactivity displayed by children with currently depressed mothers versus those with non-depressed mothers. At 2 years, the observed power in this test was 27.1% and at 3 years it was 33.4%. The mean cortisol pattern displayed by the children remaining at the 3-year timepoint is displayed in Figure 4.3.

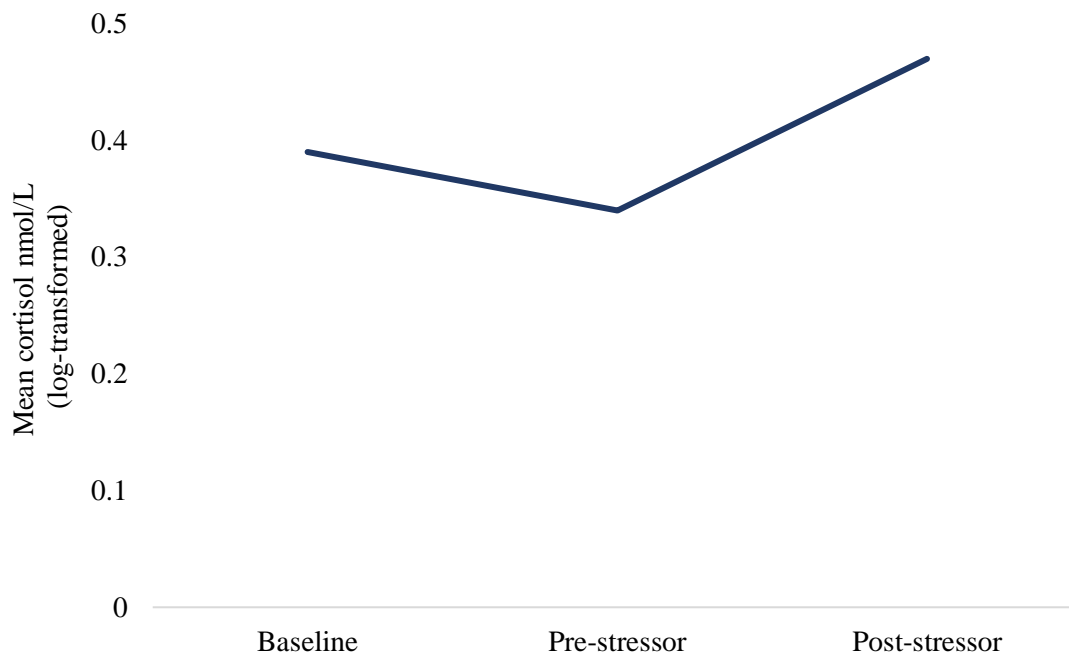


Figure 4.3. Children’s mean cortisol reactivity patterns at 3 years.

4.3.4 HPA axis activity and social-emotional outcomes

At 2 years, there were no significant associations between parents’ HPA axis activity and children’s social-emotional (SE) outcomes (see Table 4.6). However, at 3 years there was a negative association between maternal baseline cortisol and children’s SE scores, $r_s = -.428$, $p < .05$, observed power = 68.4%. No other statistically significant associations between children’s SE outcomes and parents’ HPA axis activity were observed.

Tukey’s hinges were used to identify percentiles in children’s cortisol output; the ‘lower hinge’ represents the 25th percentile, the ‘mid-hinge’ is the 50th percentile (the median) and the ‘upper hinge’ is the 75th percentile. Kruskal-Wallis tests were used to confirm that the differences in cortisol output between these three percentiles were statistically significant. Children’s SE scores were categorised similarly using Tukey’s hinges and a Kruskal-Wallis test confirmed statistically significant differences between these groups. Further Kruskal-Wallis tests indicated no significant difference in the SE scores obtained by children whose cortisol output was in the sample’s 25th versus 75th percentile.

Table 4.6*Spearman correlation coefficients for maternal antenatal, parental current HPA axis activity, and children's outcomes at 2 years.*

Cortisol variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. M antenatal baseline	1												
2. M antenatal AUCi	.102	1											
3. M 2-year baseline	.411*	.232	1										
4. M 2-year AUCi	.275	-.002	.077	1									
5. F 2-year baseline	.311	.054	.653**	.265	1								
6. F 2-year AUCi	-.351	.422	-.115	-.189	-.185	1							
7. 2-year SE	.104	.009	.214	-.033	.396	-.072	1						
8. 2-year Cog	-.056	-.020	.020	.190	.135	-.294	.346*	1					
9. 2-year Lang	-.135	.241	.101	.491*	.109	-.003	.319*	.679**	1				
10. 2-year GA	-.274	.030	-.050	.178	-.094	-.119	.190	.386**	.415**	1			
11. 2-year CA	-.201	.029	.058	.162	.091	-.199	.166	.450**	.601**	.821**	1		
12. 2-year PA	-.143	.048	-.168	.377	.101	-.207	.282*	.419**	.421**	.879**	.641**	1	
13. 2-year SA	-.147	-.154	.141	.230	-.207	-.469*	.110	.246	.226	.736**	.452**	.609**	1

Note. M = Mother; F = Father; AUCi = Area under the curve with respect to increase; SE = Social-emotional; Cog = Cognitive; Lang = Language; GA = General adaptive; CA = Conceptual adaptive; PA = Practical adaptive; SA = Social adaptive; * $p < .05$; ** $p < .01$.

4.3.5 HPA axis activity and cognitive, language and adaptive outcomes

At 2 years, there was a moderate positive correlation between mothers' CAR and their children's concurrent language scores (observed power = 77.3%), and a moderate negative correlation between fathers' CAR and children's social-adaptive scores (observed power = 62%; see Table 4.6). Mothers' and fathers' AUCi percentiles were computed using Tukey's hinges, and differences between these percentile groups were examined in relation to children's language and social adaptive outcomes. A Kruskal-Wallis test indicated that the language scores of children whose mothers' CAR was in the 25th percentile of the sample were significantly lower compared to children whose mothers' CAR was in the 75th percentile. This difference held following a Bonferroni correction for multiple comparisons, $H(2) = -8.92$, $p = .037$, $\varepsilon^2 = .32$. The observed power of this test was estimated at 58.4%.

A Kruskal-Wallis test indicated that there was no statistically significant difference in the social adaptive scores of children whose fathers' CAR was in the 25th, 50th or 75th percentiles. The observed power of this test was estimated at 27.4%. Children's cognitive, language and general adaptive scores were also examined in relation to their HPA axis activity, as indicated by Tukey's percentiles. Kruskal-Wallis tests indicated no significant differences between children who displayed atypical HPA axis activity versus those who did not, for any developmental domain at either timepoint. Spearman correlations indicated that there were no significant associations between children's HPA axis activity and cognitive, EF, language or adaptive outcomes at 2 and 3 years postpartum.

4.4 Discussion

4.4.1 Parents' HPA axis activity

The first hypothesis sought to examine differences in the HPA axis activity of mothers who had antenatal or current depression and those who did not. The current study's finding – that there was no significant difference in maternal baseline cortisol or CAR across groups, as defined by their antenatal depression status – was contrary to what had been predicted. This finding does not align with previous studies that have reported significantly higher baseline cortisol among depressed individuals (Doolin et al., 2017), and significant differences in the CARs of those who have a current diagnosis or history of depression, compared to non-depressed individuals (Aubry et al., 2010; Bhagwagar et

al., 2003). It is likely that the sample's attrition rate that resulted in a small sample size limited our ability to detect group differences. The positive association between mothers' and fathers' baseline cortisol at 2 and 3 years is in line with previous research that has found significant covariation in the HPA axis activity displayed by partners (Laws et al., 2015; Papp et al., 2013).

4.4.2 Children's HPA axis activity

Consistent with previous research, it was hypothesised that children whose mothers had antenatal or current depression would display elevated resting cortisol levels, and heightened reactivity to a stressor at 2 and 3 years postpartum. However, there were no significant group differences in children's resting cortisol or reactivity at either timepoint. No significant associations were found for parental depression scores and children's HPA axis activity, and there was no significant difference in the cortisol output displayed by male and female offspring at either timepoint.

While the study's sample size likely limited our detection of between-group differences in children's HPA activity, it is also important to consider methodological issues. The lack of significant difference in children's pre- and post-stressor cortisol levels at 2 years, indicates that the stressor paradigm used did not evoke a measurable cortisol stress response. In Gunnar et al.'s (2009) review of laboratory stressor paradigms, the authors emphasised the lack of studies that have successfully evoked induced stress responses in preschool-aged children. Jansen and colleagues' (2010) systematic review reported declining cortisol responses with age, among 0-2-year-olds. A period of hyporesponsivity has been observed in animal studies (Sapolsky & Meaney, 1986), and has been posited to emerge in early childhood, and persist until adolescence, at which point most studies examining reactivity within this age group report significant cortisol responses in reaction to a laboratory stressors (Hunter et al., 2011). Our analyses indicated that a significant stress response was evoked by the paradigm used at 3 years, which was a more emotionally challenging situation. This finding provides support for the use of a condensed version of the Strange Situation paradigm in future studies examining young children's stress reactivity.

While there were no significant associations observed between parents' and children's HPA axis activity at 2 years, elevated maternal CAR at 3 years was associated with children's concurrent higher resting cortisol. Interestingly, while antenatal maternal cortisol was significantly associated with mothers' morning cortisol at 2 years and CAR

at 3 years, there were no significant associations between antenatal maternal cortisol and children's HPA axis activity at 2 or 3 years. Hence, the current study's findings support the view that maternal and paternal HPA axis activity may continue to exert a significant influence on offspring HPA axis activity through to 2 and 3 years postpartum.

4.4.3 HPA axis activity and children's social-emotional outcomes

The current study's finding – that there was no association between children's HPA axis activity and social-emotional development – was contrary to our hypothesis, which was based on previous research that linked atypical offspring cortisol output with their social-emotional outcomes (e.g. Bagner et al., 2010). However, several features of the current study may underlie the lack of association observed. First, the majority of research that has examined children's HPA axis activity and social-emotional outcomes has focused specifically on the rate of internalising or externalising symptoms displayed by children. However, the current study's examination of social-emotional development was based on a composite score from a questionnaire designed to evaluate overall social-emotional functioning and does not include separate scales for internalising and externalising difficulties, which would have facilitated a more direct comparison of our findings with previous studies. Furthermore, the sample's attrition rate, which was higher among mothers from the original Depressed group, relative to the Control group, was likely to minimise any significant differences in children's HPA axis activity and social-emotional outcomes.

4.4.4 HPA axis activity and children's cognitive, EF language and adaptive outcomes

Based on previous studies that reported associations between atypical HPA axis activity and children's cognitive and EF outcomes, the current study examined the relationship between atypical activity displayed by parents and children and their developmental outcomes. While the hypothesised associations between children's cognitive, EF, adaptive scores and HPA axis activity were not found, there was a significant link between maternal HPA axis activity and children's language development. Children whose mothers had a significantly lower CAR than the sample median had lower language scores compared to children whose mothers had a higher CAR.

To the author's knowledge, this is the first study to examine the relationship between parents' and children's HPA activity and offspring language outcomes.

Researchers have proposed that a non-linear relationship may exist between children's

HPA activity and development, wherein abnormally high or low cortisol levels can be indicative of adverse outcomes (Doom & Gunnar, 2013). However, no research has examined how abnormally high or low cortisol output among parents may also relate to children's development in a non-linear manner. As parental depression has been associated with both atypical HPA axis activity and children's language outcomes, this finding has important implications for future research. While this finding will be re-examined in Chapter 6, wherein cortisol data will be incorporated with parents' and children's language data, it is important to note that the current study's low statistical power significantly increased the likelihood that any significant effects found were statistical artefacts that resulted from the study's high attrition rate. Hence, we must interpret the current study's findings with great caution.

4.4.5 Study strengths and limitations

This study contributes to the literature in several ways. First, there is a lack of research examining HPA axis activity as it relates to early childhood development, beyond infancy. Furthermore, most studies investigated mothers' and children's HPA axis activity only; a strength of the current study was the addition of fathers at 2 and 3 years postpartum. Those studies that have examined HPA axis activity and development during toddlerhood primarily focused on cognitive development and EF. However, children's language and adaptive behaviour have both been found to relate to parental depression. Hence, the inclusion of these domains represents another strength of the current study.

Several limitations should be noted. A major issue with the current study is the small sample size. Decreased statistical power prevented the analysis of multiple variables and impeded the current study from comparing the HPA axis activity of parents and children by parents' current depressive symptom severity. The study's reduced power lessened the likelihood of detecting true group differences. Furthermore, the significant association found between maternal CAR and children's language scores is likely to be spurious due to the study's low power. Another limitation lies in the manner in which saliva samples were collected, which may have introduced sampling error. The collection of children's saliva samples in the laboratory may not have provided an accurate indicator of their cortisol levels, particularly the baseline measure which was collected within 15 minutes of the family's arrival to the laboratory. The laboratory was a novel setting, which may have acted as a stressor in itself. Hence, a longer period, e.g., 30 to 45 minutes may have facilitated children's greater acclimation to the laboratory. In Tolep and Dougherty's (2014) study of preschool-aged children's cortisol reactivity, they attempted

to control for children's potential cortisol response to the novelty of the setting by conducting assessments over two visits, wherein saliva samples were collected during the second lab visit only, by the same researcher the child had met at the previous visit, and after 30 minutes of quiet play to facilitate the child's acclimation to the environment. Such measures, while beyond the scope of the current study, would strengthen future research examining the cortisol reactivity of 2- and 3-year-olds.

Furthermore, parents completed their own saliva sampling at home, which also could have led to inaccuracies in the timing of sample collections, as well as potential failure to follow the guidelines correctly (i.e. no eating or drinking prior to saliva sampling). Future research would be strengthened through the use of electronic devices that remind parents to complete saliva collection, as well as providing a means to accurately record the time at which a sample was collected. Furthermore, several factors have been found to influence individuals' cortisol awakening response (CAR), including the duration that an individual slept the night before sampling (Aubry et al., 2010), and the weekday that samples were collected (Kunz-Ebrecht et al., 2004). As elevated CAR has been reported on workdays compared to weekend days, future studies may minimise potential variance by controlling for the day that samples were collected, as well as completing sampling across several days, to obtain a more robust measure of each participant's CAR.

4.4.6 Conclusions

The data in this study suggest that exposure to antenatal or current depression did not directly impact children's HPA axis activity or developmental outcomes at 2 and 3 years. The current study's finding – that children whose mothers had a flatter CAR had lower language scores than their peers whose mothers had a higher CAR – requires further examination. Chapter 6 will examine parents' and children's language use during play interactions, as well as parental warmth and responsiveness. The incorporation of parents' and children's cortisol data may further our understanding of the current study's finding. Our findings highlight the importance of longitudinally studying parents' and children's HPA axis activity, in order to examine factors influencing children's developmental outcomes over a longer term.

Chapter 5

Perinatal depression, coparenting quality and children's outcomes

5.1 Introduction

The coparenting alliance comprises two individuals with the shared responsibility of rearing a child and is one of several interdependent relationships that constitute the complex family system (McHale & Rasmussen, 1998). Due to the interdependent nature of a family, emotions evoked by interactions within one relationship may “spill-over” to interactions with other family members (Engfer, 1988; Katz & Gottman, 1996). For example, conflict within the marital relationship tends to also negatively impact the quality of interactions occurring within the coparenting and parent-child relationships (Tissot et al., 2016).

The two key components used to evaluate the quality of a coparenting relationship are coparenting support and undermining (Belsky et al., 1996; Schoppe-Sullivan et al., 2004). Coparenting support reflects the extent to which parents cooperate with each other while teaching or playing with their child. It also reflects the degree to which parents display warmth and pleasure in observing the other parent’s relationship with the child. Conversely, undermining coparenting reflects the extent to which parents appear emotionally distant towards each other. It also reflects the degree to which parents compete for their child’s attention and includes displays of displeasure in observing the other parent’s interactions with the child (Belsky et al., 1996; Schoppe-Sullivan et al., 2004). A functional coparenting relationship provides for a child’s needs, and creates a supportive, secure learning environment (McHale et al., 2002). The coparenting relationship has a more direct link to children compared to the related, yet distinct, marital relationship, and has been shown to have a greater influence on children’s outcomes, compared to other family relationships (Frosch et al., 2000; Nandy et al., 2021).

5.1.1 Parental depression and the coparenting relationship

Parental depression has been identified as a major predictor of low coparenting quality (McDaniel & Teti, 2012). However, some researchers have argued that this relationship is bidirectional, and that low coparenting quality may have a significant negative impact on parental mental health, particularly during the perinatal period (Solmeyer & Feinberg, 2011). Tissot and colleagues’ (2016) findings suggested that low coparenting support may exacerbate existing perinatal depression, and - in previously non-depressed parents - may trigger depressive symptoms (Tissot et al., 2016). Conversely, Tissot and colleagues also reported evidence for the potential alleviation in symptoms that depressed parents can experience as a result of a supportive coparenting relationship. Decreases in parental

depressive symptom severity across the perinatal period were largely attributed to the high levels of coparenting support that parents received from their partners (Tissot et al., 2016).

Low coparenting quality has also been identified as a significant predictor of ongoing depression (Figueiredo et al., 2018). In a longitudinal study examining 129 couples from pregnancy through to 30 months postpartum, participants who reported more undermining coparenting relationships had greater increases in depressive symptoms across the perinatal period, compared to participants with more supportive coparenting relationships (Figueiredo et al., 2018). Taken together, it appears that perinatal depression and coparenting quality may influence each other bidirectionally.

5.1.2 Parental depression and observed coparenting quality

Feinberg's (2003) ecological model of coparenting proposed that the relationship between coparenting quality and children's outcomes is mediated by parenting quality and parental adjustment, which encompasses parental self-efficacy and mental health. As mental health is a core component of parental adjustment, it is important to consider the influence that depression may have on parents' ability to maintain a positive coparenting relationship. Depressive symptoms, such as withdrawal and frequent displays of negative affect, increase the likelihood of coparenting conflict and distress (Conger et al., 2010; Williams et al., 2015), which in turn may bring about the negative child outcomes that are associated with low coparenting quality.

Observational research has provided evidence for the distinct associations that coparenting may have with depression among mothers versus fathers. In a cross-national study of Swiss and American coparenting, Tissot and colleagues (2016; 2019) found maternal depression scores to be significantly negatively associated with overall observed coparenting cooperation, with no such effect observed among fathers; this finding was reported in both samples. The authors suggested that previous research findings linking more significant negative effects of family relationship issues with women's mental health, may underlie this result (Milkie et al., 2008; Elliott et al., 2015).

5.1.3 Parental depression and perceived coparenting quality

While the behavioural impact that depression may have on parents' ability to engage in positive coparenting may be best assessed using observational measures, it is also important to consider the effect that depression may have on parents' perceptions of their

coparenting relationship. Existing research suggests that paternal depression may have a more significant impact on fathers' perceptions of the coparenting relationship than maternal depression has on mothers' perceptions. Several studies have found significant associations between paternal depression and lower levels of perceived support among fathers (Bronte-Tinkew et al., 2007; Bronte-Tinkew et al., 2009; Isacco et al., 2010, MacDonald et al., 2020). This association between paternal depression and a heightened likelihood of adopting a negatively-valenced perception of their coparenting relationship has been reported in fathers with depressive symptoms ranging from mild to severe (MacDonald et al., 2020). Paternal depression has also been linked to more negative perceptions of fathers' own coparenting behaviour. Elliston and colleagues (2008) reported a significant association between paternal depression scores and fathers' self-reported withdrawal in coparenting contexts. The same effect was not observed among mothers with depression, leading to the authors' suggestion that depression may have impeded fathers' ability to provide support to mothers, while maternal depression did not seem to equivalently impact mothers' supportiveness (Elliston et al., 2008).

While existing research examining parents' perceived coparenting quality largely supports the view that paternal depression has a greater impact on fathers' perceptions of coparenting than is the case for maternal depression, some findings must be interpreted with caution. For example, in Bronte-Tinkew and colleagues' (2007; 2009) studies, only fathers' perceptions of coparenting quality were examined. As coparenting is a dyadic process, both parents' perceptions should be examined to gain a clearer insight into the overall relationship.

Furthermore, several non-coparenting-focused studies (Du Rocher Schudlich et al., 2011; Williams et al., 2015) have provided evidence for a "cross-over" effect of one partner's depression influencing the other partner's subsequent perception of their relationship. The only study to examine such cross-over effects of depression in a coparenting context was conducted by Williams (2018). The findings from this study provided partial support for the crossover theory; paternal depression scores at 3 years postpartum were associated with mothers' lower coparenting perceptions at 5 years postpartum. Maternal depression scores were found to have a cross-over effect on fathers' later perceptions of coparenting quality, which Williams (2018) argued may be partially explained by the nurturant-role hypothesis. From this perspective, mothers may continue to provide support to family, even during times of personal ill-health (Gove, 1984; as cited by Williams, 2018). In such cases, mothers' depression may not significantly impact

fathers' perceptions of coparenting, particularly in cases of milder depression, wherein mothers' ability to positively engage with others, in general, is less likely to be impeded. As Williams' (2018) study was the first to examine depression and coparenting from a dyadic cross-over perspective, and was based solely on self-report, further research incorporating observational measures is required to clarify the differences between mothers' and fathers' observed and perceived coparenting quality that may arise in families affected by maternal and/or paternal perinatal depression.

5.1.4 Parental depression, coparenting quality and children's outcomes

Coparenting quality has been identified as a significant predictor of offspring outcomes, from infancy through to later adolescence (Feinberg et al., 2007). Low coparenting quality has been found to account for a significant proportion of social-emotional deficits in children, including depressive symptoms (Katz & Low, 2004), conduct issues (Schoppe et al., 2001; Murphy et al., 2016), and poorer social skills (Cabrera et al., 2012). Longitudinal research has provided evidence for the protective effect that supportive coparenting has for children's development, even while controlling for parents' relationship satisfaction (Feinberg et al., 2007).

While most research examining associations between coparenting and children's outcomes has focused on psychosocial functioning, other developmental domains have been investigated in the literature, albeit to a lesser degree. For example, children's language development was examined in a study by Bingham et al., 2013. One of the coparenting dimensions examined - parental balanced involvement (the proportion of time that parents interacted with the child simultaneously) - was found to significantly predict the quantity and quality of fathers' language, while no such associations were reported for mothers' language. As mothers typically produce more speech than fathers in triadic interactions, Bingham and colleagues (2013) suggested that parental balanced involvement is likely to represent a source of implicit maternal support towards fathers. This finding suggests that maternal supportive coparenting may have an indirect positive influence on children's language outcomes, given the fact that fathers' language quantity and quality have been reported to uniquely contribute to children's expressive ability at 2 and 3 years of age (Pancsofar & Vernon-Feagans, 2006; 2010).

Another developmental domain that requires further examination in coparenting research is that of adaptive development, which serves as an indicator for children's acquisition and execution of skills that enable them to independently navigate their

environments (Bayley, 2006). In the first coparenting study to examine this domain, Nandy et al. (2021) reported that observed undermining coparenting was associated with poorer adaptive outcomes for children, namely their social and communicative skills. Furthermore, mothers' negative perceptions of the coparenting relationship were also associated with toddlers' poorer communication. As Nandy and colleagues' (2021) study was the first to examine this developmental outcome with regard to coparenting, further research examining coparenting quality and children's adaptive development is required in non-clinical and clinical samples.

Feinberg's (2003) ecological model proposed that the relationship between coparenting quality and children's outcomes may be mediated by parenting quality and parental adjustment - a construct that comprises parental self-efficacy and mental health. Research has since begun to consider the potential bidirectionality of the relationship between coparenting quality and parental mental health - specifically depression - and the mechanisms through which supportive coparenting can have a buffering effect for young children exposed to parental depression. Hence, more recent research examining this relationship has investigated the mediating effect that supportive coparenting may have on the relationship between parental depression and offspring outcomes, particularly during the perinatal period. In Tissot and colleagues' (2016) study of coparenting, postpartum depression and 18-month-olds' outcomes, coparenting support was found to mediate the relationship between maternal depression scores and children's externalising symptoms, but this association was not found for fathers. Increased maternal depressive symptoms were associated with lower coparenting support, which in turn predicted children's development of externalising issues. This finding is consistent with non-clinical research that has reported low coparenting quality as a significant predictor of children's behavioural issues (Schoppe et al., 2001; Murphy et al., 2016).

While existing research has furthered our understanding of the associations between parental depression and coparenting quality, there is a lack of research examining the mediating role that observed and perceived coparenting support may have on the relationship between children's exposure to parental depression and their wider developmental outcomes.

5.1.5 The current study

The current study examined associations between perinatal depression, coparenting quality and children's outcomes at 2 years postpartum. Parents' depression was assessed

using Hamilton Depression Rating Scale (HAM-D)-based interviews and self-report measures. Parents' observed coparenting quality was evaluated using a global rating system by Dr. Angana Nandy, a former PhD student who was trained by Sarah Schoppe-Sullivan in the use of her rating scale, and was blind to participants' group membership. Parents also completed self-report questionnaires, which yielded scores for their perceived coparenting quality. Children's social-emotional, cognitive, language and adaptive development were assessed using the Bayley Scales of Infant Development (BSID-III). Based on prevalent findings in the literature, the following hypotheses were formed:

Hypothesis 1: Observed coparenting quality and parental depression

Based on Tissot et al.'s (2016; 2019) findings, we predicted that maternal depression scores would be negatively associated with observed coparenting quality, while no such association would exist between paternal depression scores and observed coparenting quality.

Hypothesis 2: Perceived coparenting quality and parental depression

We hypothesised that current paternal depression scores would be significantly linked to fathers' negative perceptions of the coparenting relationship, while the same association would not be found between maternal depression scores and mothers' perceived coparenting quality. However, based on Williams' (2018) study on longitudinal cross-over effects, we hypothesised that paternal depression scores at 2 years would be associated with increased maternal perceived undermining at 3 years.

Hypothesis 3: Coparenting quality and children's outcomes

We predicted that low observed and perceived coparenting quality would be significantly negatively correlated with children's social-emotional, cognitive and language scores. Based on Nandy et al.'s (2021) study of coparenting and children's adaptive development, we hypothesised that observed undermining coparenting would be associated with children's poorer adaptive scores. Furthermore, we predicted that mothers' perceived undermining would also be negatively associated with children's adaptive communicative skills.

Hypothesis 4: Mediating effect of coparenting support

In our recent study (Nix et al., 2021) – the first, to our knowledge, to examine associations between maternal perinatal depression and children’s adaptive development – depressed mothers’ 2-year-olds were found to have superior social adaptive skills compared to their peers who were not exposed to perinatal depression. As Nandy et al. (2021) reported significant negative associations between observed and maternal perceived undermining and children’s social adaptive scores, we predicted that coparenting support would mediate the relationship between children’s exposure to maternal depression and their enhanced adaptive development.

5.2 Method

5.2.1 Participants

The current study examined 34 families with 2-year-old children, who were recruited during pregnancy for the REDEEM group’s longitudinal study on perinatal depression and children’s development. The current study’s data collection was conducted at the fifth timepoint, 2 years postpartum. Of the 34 sets of parents who were eligible for coparenting rating, 15 had been originally recruited to the Control group, 12 had been recruited to the History of Depression group, and 7 had been in the Depressed group. All of the parents spoke English, and interactions were triadic; no siblings were present for the play interactions included in the current analyses. All play interactions took place at the Infant and Child Research Laboratory, Trinity College Dublin.

5.2.2 Parental Measures

Parental Clinical Measures

Both parents completed interviews based on the Hamilton Depression Rating Scale (HAM-D; Hamilton, 1960), as well as self-report questionnaires: the Center for Epidemiologic Studies - Depression Scale (CES-D; Radloff, 1977), and the Perceived Stress Scale (PSS; Cohen et al., 1983). Details of these measures have been provided in Chapter 2.

Coparenting Relationship Scale (CRS; Feinberg et al., 2012)

The Coparenting Relationship Scale (CRS) is a self-report questionnaire, designed to evaluate parents' perceived quality of their coparenting relationship. This measure has demonstrated good reliability and stability (Feinberg et al., 2012), is based on Feinberg's (2003) coparenting framework, and comprises seven subscales: coparenting agreement, closeness, support, undermining, endorsement of partner's parenting, division of labour and child's exposure to conflict. As the current study focused on perceived and observed levels of supportive and undermining coparenting, only these subscales of the CRS were included in the analyses. Respondents were asked to select the option that best captured the way in which they behave as coparents, from 0 (not true of us) to 6 (very true of us). The coparenting support subscale score is based on six items of the scale, while the undermining composite is based on another six items. As a 0-6 Likert scale was used in the questionnaire, parents' scores for perceived support and undermining were both out of a total possible score of 36. Both parents completed the 35-item questionnaire, in order to yield individual scores for each parent's perception of their coparenting relationship. In the current study, internal consistency (Cronbach's alphas) for mothers' perceived coparenting support, coparenting undermining, and endorsement of partner's parenting were .79, .69 and .45 respectively. Internal consistency for fathers' perceived coparenting support, undermining and endorsement of partner's parenting were $\alpha=.78$, $\alpha=.72$, and $\alpha=.56$ respectively.

Observed Coparenting Quality (Cowan & Cowan, 1996)

In the current study, triadic mother-father-child free play interactions were video-recorded using Mangold VideoSync Pro 1.5. The laboratory's triadic free play protocol involves the presentation of a box containing a variety of toys, including a Mister Potato Head, toy cars, soft football and building blocks. Parents were asked to play with their child as they would at home. Each free play interaction was video-recorded for 10 minutes, for subsequent coparenting quality ratings.

Coparenting quality was evaluated using a global rating scale designed by Cowan and Cowan (1996) and widely used in the coparenting literature (Schoppe-Sullivan et al., 2004; Schoppe-Sullivan et al., 2009). This system uses a five-point scale, ranging from very high to very low, and assesses the rates of supportive and undermining coparenting behaviours exhibited by parents during a triadic interaction. A rating for coparenting supportiveness was yielded by scoring parents' cooperation, warmth and pleasure during

the triadic interaction. Cooperation refers to the extent to which parents supported each other during the play interaction, warmth refers to the frequency of positive regard and affection displayed towards each other, and pleasure refers to the extent to which parents seemed to enjoy their co-parental role and observing the other parent interacting with their child. The level of undermining coparenting exhibited by parents during the play interaction was also rated using three subscales: competition, coldness and displeasure. Competition refers to parents' attempts to outdo each other while interacting with their child, coldness refers to the extent to which parents displayed low affection and/or a lack of responsiveness towards each other. Displeasure refers to the extent to which parents displayed a lack of enjoyment in the play interaction. An individual rating for each parent was assigned for the warmth, coldness, pleasure and displeasure subscales, while the cooperation and competition subscale scores were jointly based on both parents' coparenting behaviours. The current study included composite scores, with a possible range from 1-5, for parents' observed coparenting support and undermining.

5.2.3 Child Measures

Bayley Scales of Infant and Toddler Development (BSID-III; Bayley, 2006)

The cognitive, language, social-emotional and adaptive behaviour scales of the BSID-III were administered to children. Information regarding the scoring and reliability of these scales was provided in Chapter 2.

5.2.4 Statistical Analyses

All data were analysed using SPSS (Version 26, IBM). The significance level was set at 0.05 for all analyses. In order to examine the first hypothesis – that maternal antenatal and current depression scores would be negatively associated with observed coparenting quality, while no such association would exist for paternal depression scores – differences in observed coparenting between mothers' antenatal groups were first examined. Kruskal-Wallis tests were selected due to the uneven group sizes and heterogeneity of variance in the data. Post-hoc Bonferroni tests corrected for multiple comparisons. Upon identifying a lack of linearity in the data, Spearman rank-based tests were used to examine associations between observed supportive and undermining coparenting and parents' current depression scores.

In order to examine the second hypothesis, which investigated associations between parents' current depression scores and their perceived coparenting quality,

Spearman rank-based correlations were conducted to examine associations between each parents' mood scores (HAM-D, CES-D and PSS) and their perceived coparenting quality. In order to test the second part of this hypothesis – that paternal depression scores at 2 years would be associated with increased maternal perceived undermining at 3 years – we examined associations between fathers' depression scores at 2 years and mothers' perceived coparenting CRS scores at 3 years using Spearman rank-based tests. In order to examine the third hypothesis, which predicted that low coparenting quality would be negatively associated with children's social-emotional, cognitive and language scores, we examined the results of Spearman rank-based tests for all developmental outcome scores at each timepoint alongside parents' observed and perceived coparenting quality. Finally, the fourth hypothesis predicted that coparenting support would mediate the relationship between children's exposure to maternal depression and their enhanced adaptive development. This mediation analysis was conducted using PROCESS, a regression-based SPSS macro (Hayes, 2013). PROCESS assesses the relationship between a predictor variable and an outcome variable, through their relationship with a mediating variable. The recommended bootstrapping method of 5000 samples, and confidence intervals of 95% were used in the current study. This bootstrapping method was selected for use in the current study as it is a non-parametric technique that does not make assumptions regarding the distribution shape, and it is not based on large-sample theory, so is suitable for use with small samples (Preacher & Hayes, 2004).

5.3 Results

5.3.1 Group differences in observed and perceived coparenting quality

A series of Kruskal-Wallis tests indicated no significant group differences for parents' perceived or observed coparenting quality. Descriptive data and group comparison results are displayed in Table 5.1 below. The observed power for Kruskal-Wallis between-group tests was estimated to be 25.5% for mothers' perceived coparenting support, and 12.3% for mothers' perceived coparenting undermining. Observed power was estimated at 14.5% for fathers' perceived coparenting support and 17.3% for fathers' perceived coparenting undermining.

Table 5.1*Descriptive data for parents' perceived and observed coparenting quality at 2 years.*

Coparenting measure	Control		History		Depressed		Group comparisons Test statistic, <i>p</i> value
	Mdn	IQR	Mdn	IQR	Mdn	IQR	
Mothers' perceived support	33	5.5	31.5	12.75	31	11.5	$\chi^2(2) = 3.554, p = .169$
Mothers' perceived undermining	2	7.5	1	6.25	4	10.5	$\chi^2(2) = .833, p = .659$
Fathers' perceived support	32.5	8.25	29	8.5	34	16	$\chi^2(2) = 1.868, p = .393$
Fathers' perceived undermining	4.5	9.5	3	4	8	8	$\chi^2(2) = .799, p = .671$
Observed coparenting support	2.80	1.40	3.10	1.35	2.80	1.60	$\chi^2(2) = .723, p = .697$
Observed coparenting undermining	1.00	0.40	1.00	0.35	1.20	0.40	$\chi^2(2) = .338, p = .845$

Note. Perceived coparenting quality score was marked out of a total possible score of 36, while observed coparenting quality was rated on a scale from 1-5.

Due to the current study's violations to the assumptions underlying parametric analyses, rank-based Spearman correlations were computed for parental mood, observed and perceived coparenting quality, and children's developmental outcomes. The results are displayed in Table 5.2.

5.3.2 Parental depression and observed coparenting quality

When parental depression scores and observed coparenting quality ratings were examined, no significant correlations were found between coparenting support or undermining and either parents' depression scores (see Table 5.2).

5.3.3 Parental depression and perceived coparenting quality

Parents' current depression scores were examined alongside their perceptions of the coparenting relationship. While there were no significant correlations between mothers' HAM-D scores and any measure of coparenting quality, there were significant moderate correlations observed between maternal PSS and mothers' perceived coparenting quality (observed power = 70.7%), as well as a weak positive correlation between mothers' CES-D scores and mothers' perceived undermining coparenting (observed power = 51.6%; see Table 5.2). Furthermore, while fathers' HAM-D and PSS scores were not significantly correlated with any coparenting variable, paternal CES-D scores were positively correlated with fathers' perceived undermining within the coparenting relationship (observed power = 41.8%) and were also significantly negatively correlated with mothers' perceptions of supportive coparenting (observed power = 75.1%; see Table 5.2).

To examine the potential cross-over effect of paternal depression on mothers' subsequent perceptions of their coparenting relationship, Spearman rank-based correlations were used to first examine associations between paternal HAM-D and CES-D scores at 2 years, and mothers' CRS scores for perceived coparenting quality at 3 years. No significant correlations were observed between either paternal depression measure and mothers' subsequent perceived coparenting quality.

Table 5.2*Spearman correlations for parental mood, perceived and observed coparenting and children's developmental outcomes.*

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. M HAM-D	1														
2. M PSS	.391**	1													
3. M CES-D	.467**	.714**	1												
4. F HAM-D	.308*	-.187	.119	1											
5. F PSS	-.041	-.100	-.320*	.389*	1										
6. F CES-D	.042	-.027	-.309*	.480**	.602**	1									
7. M SUP-P	-.254	-.43**	-.228	-.112	-.227	-.419**	1								
8. M UND-P	.041	.378**	.263*	-.038	-.054	.097	-.539**	1							
9. F SUP-P	-.002	-.339*	-.183	-.123	-.196	-.132	.269*	-.073	1						
10. F UND-P	.090	.062	-.009	.192	.068	.282*	-.273*	.471**	-.300*	1					
11. OBS SUP	-.071	.011	.123	.069	.269	.041	.104	-.034	.033	-.094	1				
12. OBS UND	-.095	-.316	.030	.228	.009	-.064	-.149	-.011	.052	-.165	-.361*	1			
13. C SE	-.100	-.218	-.203	-.183	.164	.057	.222	-.35**	-.107	-.003	.271	-.176	1		
14. C COG	-.095	-.251	-.272	-.097	-.183	-.028	.197	-.168	.044	-.032	-.297*	.187	.346*	1	
15. C LANG	-.013	-.265	-.268	.183	-.098	.079	.210	-.121	.024	.153	-.060	.004	.319*	.679**	1

Note. M = Mother; F = FAT; C = Child; SUP = Support; UND = Undermining; P = Perceived; OBS = Observed; SE = Social-emotional; COG = Cognitive;

LANG = Language; * $p < .05$; ** $p < .001$.

5.3.4 Coparenting quality and children's outcomes

The only significant association between observed coparenting quality and children's outcomes was a negative correlation between parents' observed supportiveness and children's cognitive scores (observed power = 45.5%; see Table 5.2).

Spearman correlations also indicated a moderate negative correlation between children's social-emotional development and mothers' perceived undermining in the coparenting relationship (observed power = 59%). No statistically significant correlations were found for any aspect of coparenting quality and children's language (see Table 5.2).

5.3.5 Coparenting quality and children's adaptive behaviour outcomes

No significant associations were found between any aspect of coparenting quality and children's adaptive outcomes (see Table 5.3). Subsequent mediation analyses confirmed the absence of the hypothesised statistically significant indirect effect of coparenting support on children's adaptive scores, as indicated by the model's 95% confidence intervals containing zero.

Table 5.3

Spearman correlations for children's general adaptive scores and coparenting quality.

GA scores	M-PS	F-PS	M-PU	F-PU	O-S	O-U
Conceptual	.182	.027	-.050	.130	-.028	.060
Practical	-.006	-.101	.090	.257	-.080	.175
Social	-.095	-.169	.149	.199	.084	.121
Composite	-.010	.001	.094	.208	-.014	.129

Note. GA = General Adaptive; M = Mothers'; F = Fathers'; PS = Perceived Support; PU = Perceived Undermining; O-S = Observed Support; O-U = Observed Undermining.

5.4 Discussion

5.4.1 Observed coparenting quality and parental depression

The first hypothesis sought to examine associations between parental depression scores and observed coparenting quality. When these variables were assessed, no significant correlations were observed. While the lack of significant association between paternal depression scores and observed coparenting quality was predicted, based on Tissot and colleagues' (2016; 2019) findings, the lack of association between maternal depression scores and coparenting quality was not.

Tissot and colleagues reported a negative association between depression scores and observed coparenting quality, which was unique to the mothers in their sample, implying that maternal depression had a stronger relationship with the overall coparenting supportiveness exhibited during triadic interactions (Tissot et al., 2016; 2019). The current study's lack of replication is likely due to sample attrition, which led to significantly reduced power. It is also possible that the women in the current study were not as severely depressed as the mothers sampled by Tissot et al., and hence, did not display equivalent coparenting deficits. Individuals with higher depressive symptom severity are more likely to display the behavioural and cognitive depressive symptoms that Feinberg (2003) posited would be likely to hinder depressed parents' ability to engage in supportive coparenting behaviours.

It is also important to note that Tissot and colleagues' (2016; 2019) studies were the first to examine associations between both parents' perinatal depression scores and observed coparenting quality, and hence, further research is required to validate their findings. This is particularly important given the fact that non-clinical research examining other family dynamics, such as marital quality, has provided evidence for the significantly greater influence that such dynamics appear to have on fathers' involvement in family interactions, compared to mothers' (Lamb, 2004). As such research implies a greater sensitivity among fathers to the effects of family dynamics, further research is required to ascertain the specific aspects of maternal and paternal depression that represent significant risk factors for low coparenting quality.

5.4.2 Perceived coparenting quality and parental depression

Based on prevalent findings in the literature, we predicted a significant negative association to occur between paternal depression scores and fathers' coparenting perceptions, and no such association to be found for mothers and their perceived coparenting quality. Our findings supported our hypothesis for fathers, as a significant positive correlation was observed between paternal CES-D scores and fathers' perceived levels of undermining coparenting. However, the weak positive correlation between maternal CES-D scores and mothers' perceived undermining was unexpected.

Current research on perceived coparenting quality supports the view that paternal depression has a greater impact on fathers' coparenting perceptions than maternal depression has on mothers' perceptions. However, the studies that argued for this difference between mothers and fathers had methodological issues, such as the sole examination of fathers' perceived coparenting quality, which limits their ability to generalise findings to mothers (Bronte-Tinkew et al., 2007; 2009). As coparenting is a dyadic process, both parents' perceptions should be examined to gain a clearer insight into overall relationship quality.

Furthermore, the current study reported a positive association between maternal depression scores and mothers' negative perceptions of the coparenting relationship. In the first two years postpartum, mothers are typically the primary caregivers, while fathers' involvement in caregiving has been generally reported to increase as children get older (Diniz et al., 2021). Such increased father involvement has been linked to mothers' increased evaluations of fathers' parenting (Williams, 2018). As depression is associated with the development of more negatively-valenced views in general, the current finding – if replicated by large, adequately powered studies – may relate to depressed mothers' increased likelihood of viewing family dynamics, including fathers' coparenting, in a negative light. It is very important to note again that the study's small sample size and reduced power means that the likelihood of spurious findings was high.

A recent dyadic examination of depression, perceived coparenting quality and longitudinal cross-over effects was conducted by Williams (2018). Based on the findings from this study, we hypothesised that paternal depression scores at 2 years would be significantly associated with maternal perceived coparenting quality at 3 years. However, no significant correlations were observed between fathers' CES-D or HAM-D scores and mothers' subsequent scores for perceived coparenting quality. The lack of evidence for a

cross-over effect in the current study may be due to the study's small sample size, and the generally low levels of undermining coparenting observed across groups.

5.4.3 Observed coparenting quality and children's outcomes

While we predicted that low ratings of observed coparenting quality would be negatively correlated with all developmental domains, no such associations were found for children's language or adaptive scores. This is contrary to previous studies, which linked observed negative coparenting with adverse outcomes for children (Cabrera et al., 2012; Katz & Low, 2004). In the current sample, the low proportion of severely depressed parents likely underlies the lack of variation in coparenting quality ratings given to parents. As shown in Table 5.1, there were no significant group differences for any aspect of coparenting, and levels of support were relatively high across groups, which limits our ability to generalise to the wider population, particularly to those parents with more severe depression.

In direct contradiction to our hypothesis, the only significant association found for observed coparenting quality and child development was a negative correlation between parents' observed supportiveness and children's cognitive scores. If this finding was replicated it would imply that when parents were more supportive towards each other, children's cognitive outcomes were negatively impacted. While our hypothesis was based on previous research that emphasises the benefits of coparenting support for children's development in general, few coparenting studies have examined cognitive outcomes, with the majority focussing on the impact of coparenting on children's social-emotional functioning. The current study's finding may reflect a heightened partner-focus between parents, as opposed to a more balanced approach, which also provides adequate attention to the child during triadic interactions. Hence, while the child may be playing in a positive, warm environment, parents who are very attentive to their partner during play interactions may be inadvertently providing less direct cognitive stimulation to the child than a less partner-focused, but equally interactive, set of parents. It is very important to consider that while future adequately powered research should further examine the relationship between these variables, it is likely that the negative association between parents' observed supportiveness and children's cognitive scores was a statistical artefact arising from the study's low power. Future largescale research is required to examine individual components of the supportive and undermining subscales and how they may relate to specific developmental outcomes.

5.4.4 Perceived coparenting quality and children's outcomes

When the associations between perceived coparenting quality and children's outcomes were examined, a moderate negative correlation was observed between mothers' perceived undermining coparenting and children's social-emotional scores. This finding was in line with our hypothesis that low coparenting quality would be negatively linked with this aspect of child development. However, the same association was not observed for fathers' perceptions of undermining and children's social-emotional development. Our finding indicates that children's social-emotional deficits are linked with how unsupportive mothers perceive their coparenting relationship to be, while fathers' perception of the relationship does not have an equivalent effect.

One possible explanation for this finding is that children's social-emotional outcomes were negatively impacted by a lack of paternal involvement, as indicated by mothers' negative perceptions of the coparenting relationship. However, the lack of association between observed coparenting and children's social-emotional outcomes does not support this idea. Another possibility is that children with social-emotional issues may evoke stress in the mother and increase mothers' likelihood of forming a negatively-valenced view of the family dynamics at play during parent-child dyadic or triadic interactions. A difficult temperament has been linked to coparenting conflict, as parents who experience increased challenges associated with temperament issues tend to require additional support from their partner (Kornienko, 2016). During early childhood, mothers tend to lead caregiving within the family. Hence, the mothers of children with social-emotional issues may require more support than mothers with less difficult children, which may underlie a greater tendency to view their coparenting relationship in a negative light.

5.4.5 Mediating effect of coparenting support on children's adaptive development

Based on the significant positive association between maternal depression and children's social adaptive development reported in Chapter 3, and Nandy et al.'s (2021) finding relating undermining coparenting to children's social adaptive deficits, we hypothesised that coparenting support would mediate the positive relationship between children's exposure to maternal depression and their social adaptive scores. However, our mediation analysis indicated no significant indirect effect of coparenting support on children's adaptive scores. Several factors may underlie this finding. First, while supportive coparenting has been consistently linked with positive child outcomes, most research that

has provided evidence for this link has examined social-emotional functioning. Nandy and colleagues' (2021) study was the first to incorporate children's adaptive development into an analysis of coparenting quality and child outcomes. Nandy et al.'s study was also based on a non-clinical sample, and so, further research is required in both clinical and non-clinical contexts, to investigate the link between undermining coparenting and children's adaptive outcomes.

5.4.6 Study strengths and limitations

The current study had several strengths, including the use of observational and self-report measures of coparenting quality, the blind rating of coparenting exhibited during play interactions, and a wider examination of children's developmental domains than is typical of coparenting research. However, several limitations should also be noted. The laboratory setting in which play interactions took place represented a novel environment for children and their parents. While families were given time to familiarise themselves with the room prior to any recording of interactions, there is still the possibility that the behaviours and overall family dynamics exhibited were not representative of the family's typical everyday interactions, thus limiting the ecological validity of the findings.

Furthermore, the study's low power significantly reduced our ability to detect true group differences, while simultaneously increasing the likelihood that significant effects found were merely statistical artefacts. Additionally, due to the small sample size, the various aspects of coparenting were condensed into the broad domains of supportiveness and undermining for the purpose of analyses. Future research with larger sample sizes could examine associations between individual aspects of each domain, e.g. coparenting pleasure and displeasure, and children's outcomes, to give more detailed insights into the coparenting behaviours that are most influential on triadic dynamics and children's development.

5.4.7 Conclusions

This study sought to contribute to the coparenting literature by examining the observational and perceived coparenting quality exhibited by parents with varying experiences of perinatal depression, at 2 years postpartum. The study's findings for parental perceptions of coparenting challenge the widely-held view that paternal depression has a greater impact on father's coparenting perceptions than maternal depression has on mothers' perceptions. While the association between maternal depression scores and mothers' perceptions of undermining coparenting was weak, the

lack of consistency in previous studies that posited fathers' perceptions to be more significantly impacted by depression, calls for further research to examine coparenting perceptions in a dyadic context.

To the author's knowledge, only one study (Williams, 2018) has conducted dyadic examinations of cross-over effects between parental perinatal depression and coparenting quality. Unlike Williams (2018), the current study found no significant associations between paternal depression scores and mothers' subsequent coparenting perceptions. However, further research with larger samples may further our understanding of the longitudinal effects that one parent's depression may have on their partner's subsequent coparenting perceptions, as well as on the overall observed coparenting quality.

In general, the coparenting interactions observed in the current study were largely supportive in nature. The lack of negative association between lower ratings of coparenting quality and children's outcomes also implies that the current sample's parents provided adequate support to each other. The negative association found between observed coparenting supportiveness and children's cognitive outcomes was unexpected and requires further examination. If larger studies replicated this finding, further examination of individual components of the major coparenting domains may reveal the specific aspect of supportiveness that accounted for the decrease in parental focus on the child during triadic play, hypothesised to be a potential factor underlying our finding. Future research would be strengthened through use of both observational and self-report measures, and the examination of all major domains of child development, in order to gain a more comprehensive insight into coparenting quality, and the role that it may play in the relationship between children's exposure to perinatal depression and their subsequent outcomes.

Chapter 6

Perinatal depression, postnatal parenting behaviours and children's developmental outcomes at 2 and 3 years postpartum

6.1 Introduction

The Developmental Origins of Health and Disease (DOHaD) hypothesis posits that early life experiences play a significant role in the subsequent development of psychopathology (Barker, 1990, 2007). The first three years of life constitute a time in which children's later development is significantly influenced by the quality of their postnatal environment. This significant influence underlines the importance of examining the parenting behaviours that children are exposed to in the context of perinatal depression.

6.1.1 Parent-child interaction quality and parental depression

The quality of environmental input provided to young children revolves primarily around the supportiveness of their caregivers' behaviours (Topping et al., 2013). Parents support their children's development through the provision of appropriate challenges to facilitate children's learning, while maintaining a warm, responsive environment (Foster et al., 2007). Adverse developmental outcomes associated with children's exposure to perinatal depression may be moderated by issues within parent-child interactions. For example, lower rates of joint attention (Goldsmith & Rogoff, 1997), as well as less effective use of child-directed speech (Field, 2010; Rowe et al., 2005) have been associated with maternal depression.

Tronick and Reck's (2009) model of maternal depression transmission posits that during interactions between depressed mothers and their children, mothers' reparation process following affective or behavioural mismatching generally does not occur as efficiently as is seen in non-depressed mother-child interactions. Repeated cycles of mismatching and delayed repair result in a greater proportion of interaction time spent in a negative affective state, which may lead to the child's formation of a negatively-valenced view of their mother (Tronick & Reck, 2009), and self-regulation deficits (DiCorcia & Tronick, 2011). Similar evidence for the impact that depression may have on the quality of interactions between fathers and their children has also been provided. In studies examining father-child interactions during the early postnatal period, depressed fathers have been found to display increased withdrawal and lower levels of active engagement, compared to their non-depressed peers (Koch et al., 2019; Sethna et al., 2015; Sethna et al., 2018).

Parent-child interactions that flow in a coordinated manner may be described as synchronous. Such interactions require parent and child to respond readily to each other, with sufficient emotional capacity to provide appropriate responses (Leclère et al., 2014;

Stein et al., 2018). Studies investigating the quality of children's postnatal environments typically examine positive parenting behaviours that facilitate this synchrony. Such positive aspects of parenting include parental warmth, responsiveness and effective use of child-directed speech.

6.1.2 Parental warmth and perinatal depression

Parental warmth, or affection, are terms used to describe caregiving behaviours that exhibit support and enthusiasm towards their child (Roggman et al., 2013). Parental warmth is associated with enhanced social-emotional and cognitive outcomes during toddlerhood (Baker, 2018), and high levels of maternal warmth during the postnatal period have been found to predict lower rates of psychopathology in adult offspring (Maselko et al., 2011). More recently, Anderson and colleagues' (2021) longitudinal study of maternal warmth and children's anxiety found that maternal warmth at 7 years predicted children's decreased anxiety at 8 years of age (Anderson et al., 2021). In contrast, low parental warmth has been linked with children's increased risk of developing externalising (Buschgens et al., 2010) and internalising symptoms, including low mood and anxiety (McLeod et al., 2007). While a positive association between warmth and offspring outcomes has been reported in research examining both parents, comparatively fewer studies have examined fathers' warmth and its associations with children's development (Pinquart et al., 2017).

The literature examining the impact of depression on mothers' caregiving behaviours has provided evidence for the negative impact that depression may have on maternal warmth (Baker, 2018; Hummel et al., 2015). One aspect of depression that may elucidate the basis for this link lies in the cognitive patterns associated with depression (Gotlib & Joormann, 2010). Depressed individuals have a tendency to display increased self-focus, compared to their non-depressed peers (Grimm et al., 2009). This heightened self-focus may decrease parents' ability to appropriately attend during play, and thus may hinder warm interactions with their child. For example, in a study examining mothers' narratives about their 6-month-old infants, Humphreys and colleagues (2018) found that maternal depressive symptoms were associated with increased self-focus. Additionally, this self-focus was found to mediate the relationship between maternal depression and reduced warmth displayed during an interaction with their child (Humphreys et al., 2018).

While the literature examining fathers' warmth is lacking, one study that did investigate this aspect of parenting in fathers was conducted by Lee and colleagues

(2018), which examined differences in the impact of paternal warmth among 3-year-old children with residential versus non-residential fathers. While there were no significant associations between residential fathers' depressive symptoms, warmth and children's behaviour, higher levels of paternal warmth were significantly linked to fewer child behavioural issues among those with non-residential fathers (Lee et al., 2018). This finding supports the view that fathers' warmth may play an important role in children's social-emotional functioning, particularly for children who may spend less time with their fathers than their peers with fathers at home. Further research is required to elucidate the importance of each parent's level of warmth, for offspring exposed to parental depression during early childhood.

6.1.3 Parental responsiveness and perinatal depression

Parental responsiveness – a term that is often interchanged with 'sensitivity' – functions to reinforce a child's parent-directed behaviours (Gewirtz, 1991). Parents typically provide this reinforcement by responding to their children's cues in a warm, receptive style (Bornstein & Tamis-LeMonda, 1989, Wade et al., 2018). Contingent responsiveness, then, refers to the extent to which parental responses to children's cues are prompt and appropriate (Bornstein et al., 2008). While parents may exhibit their responsiveness in a variety of ways, including through touch, and physical games, one of the primary foci of responsiveness research has been parents' vocal behaviour, as this aspect of responsiveness is linked with a range of children's developmental outcomes (Edwards et al., 2010).

The three primary factors that have been proposed to underlie parental responsiveness are: parental well-being, children's characteristics (including temperament), and environmental factors (including social support) (Belsky, 1984; Bornstein, 2015). Considering each of these factors in relation to perinatal depression: it negatively impacts parental well-being, is associated with a heightened risk of difficult offspring temperament (Davis et al., 2007), and is also linked to lower social support (Biaggi et al., 2016). This framework for parental responsiveness supports evidence for a link between perinatal depression, and mothers' (Lanzi et al., 2009) and fathers' (Koch et al., 2019) difficulties engaging their children in a consistent, responsive manner.

6.1.4 Parental responsiveness and children's outcomes

Existing research has provided substantial evidence for the positive impact that responsive parenting has on offspring cognitive and social-emotional functioning, from childhood (Hirsh-Pasek & Burchinal, 2006; Scherer et al., 2019) through to adolescence and adulthood (Raby et al., 2014). The level of responsiveness exhibited by mothers across the perinatal period has been shown to significantly influence a range of subsequent outcomes, including executive function (Blair et al., 2011), cognitive (Lemelin et al., 2006), and language development (Tamis-LeMonda et al., 2014). A significant link between fathers' responsiveness and children's developmental outcomes has also been reported. For example, in Shannon and colleagues' (2002) study, toddlers with fathers who were rated as low in responsiveness were five times more likely to exhibit cognitive deficits than toddlers with highly responsive fathers (Shannon et al., 2002). Furthermore, in a study by Tamis-LeMonda and colleagues (2004) paternal responsiveness with 2- and 3-year-old children was found to predict their subsequent cognitive and linguistic functioning, while controlling for maternal responsiveness.

Parents' vocal responsiveness may be examined in terms of semantic and/or temporal contingence, which serve as measures of how appropriate, and prompt parents' responses are to children's cues, respectively (Landry et al., 2006). Temporal contingency is typically evaluated by measuring the proportion of child vocalisations that are responded to within a specific time window (McGillion et al., 2013). While there is a lack of consensus regarding the optimal window for parents' vocalisations to be categorised as contingently responsive, most studies opt for a 2-5 second interval of opportunity (Bakeman & Quera, 2011; Bornstein et al., 2008).

Research has provided evidence for the important role that parental vocal responsiveness plays in children's early language development, from their preverbal communication in infancy (Goldstein & Schwade, 2008, Gros-Louis et al., 2014), to the timing of the emergence of toddlers' coherent words and sentences (Tamis-LeMonda et al., 2001). In a longitudinal study of vocabulary growth across the postnatal period, infants of highly responsive mothers at 9 and 13 months reached milestones including first words, and coherent speech, 4 to 6 months earlier than infants whose mothers displayed low responsiveness (Tamis-LeMonda et al., 1998). Furthermore, Tamis-LeMonda and colleagues (2014) identified parents' vocal responsiveness as a significant predictor of children's vocabulary diversity (Tamis-LeMonda et al., 2014).

Marklund and colleagues (2015) examined the importance of parental contingent responsiveness, in a study of parental pause durations during conversations with their 18-month-old children, and investigated the link between parental response times and children's vocabulary size. Slow parental responses were associated with limited offspring vocabulary. Conversely, children whose parents provided more prompt responses had significantly larger vocabularies at 18 months compared to their peers whose parents responded more slowly. It has been proposed that the advances in children's language development, associated with increased parental vocal responsiveness, may lead to children's engagement in increasingly complex vocalisations, which may result in more prompt and advanced responses by parents, and hence, greater developmental gains for children with vocally responsive parents (Edmunds et al., 2019).

6.1.5 Conversational turn-taking and children's outcomes

Beyond examining one speaker's production of contingent vocal responses, parents' and children's vocalisations can be examined in tandem, to assess each speaker's vocal contribution to an interaction, as well as their overall conversational balance. A conversation may be viewed as a series of "mutually contingent vocal exchanges" (Bornstein et al., 2015; Stern, 1985), or back-and-forth turns that are produced by one speaker after another (Dunn & Brophy, 2005). Turn-taking underpins successful communication, and a greater balance is achieved when parents and children produce an approximately equal number of turns, of similar length (Kelly, 2020). Conversational turn-taking thus serves as an indicator for children's ability to engage in extended conversations (Leech & Rowe, 2020).

Parents' engagement in high rates of conversational turn-taking during parent-child interactions has been associated with children's enhanced social and cognitive outcomes (Dunn & Brophy, 2005; Ensor & Hughes, 2008). Gómez and Strasser (2021) examined parent-child interactions over the postnatal period and found that the number of mother-child conversational turns at 18 months significantly predicted children's social-emotional functioning at 30 months, while controlling for maternal warmth, initial social-emotional functioning, and children's vocalisations. In the area of language development, turn-taking has been identified as a significant predictor of larger vocabularies at 18 (Ferjan Ramirez et al., 2020) and 24 months postpartum (Ramirez-Esparza et al., 2017), and turn-taking between 18 and 24 months postpartum has been identified as a significant predictor of children's linguistic abilities at 10 years of age (Gilkerson et al., 2018).

Taken together, such findings provide support for the important role that early conversational turn-taking appears to play in children's development.

As turn-taking may be viewed as a simultaneous examination of two individuals' contingent vocalised responses, it is logical that the reported negative association between parental depression and responsiveness extends to include conversational turn-taking. Depressed parents tend to provide less contingent responses than their non-depressed peers. Hence, it is likely that depressed parents also produce fewer turns with their children. McDaniel and colleagues (2021) found evidence for such a link within a sample of mother-infant dyads, where a significant association between increased maternal depression and fewer conversational turns was observed between mothers and their 14-month-olds. Brookman and colleagues (2020) also reported that depressed mothers and their infants produced fewer conversational turns, and the number of conversational turns at 6 and 12 months was identified as a stronger predictor of offspring vocabulary size at 18 months than maternal depression (Brookman et al., 2020). While such findings indicate a negative effect of depression on turn-taking, which consequently impacts offspring language outcomes, to the author's knowledge, no studies have examined the impact of perinatal depression on parent-child conversational balance over a longer term, at 2 and 3 years postpartum.

6.1.6 Parental language, perinatal depression and children's outcomes

While parental vocal responsiveness plays an important role in supporting children's development across many domains, the linguistic characteristics of such vocalisations have also been identified as important factors underlying early childhood outcomes, particularly in the area of language development (Tamis-LeMonda et al., 2001). Several features of parental language are considered to be important to children's linguistic functioning, particularly the quantity and quality of parental speech used during parent-child interactions (Hart & Risley, 1995; Hirsh-Pasek, 2015). Parents' quantity of speech has been associated with children's early vocabulary growth rate (Hart & Risley, 1995; Rowe, 2012). Rowe (2012) found that the quantity of parental speech input was more important to children's linguistic ability at 2 years, while the quality of parental speech input – indicated by their vocabulary diversity – played a more significant role in children's language outcomes at 3 years.

Depression has been negatively associated with maternal language quantity and quality (Kaplan et al., 2014). While non-depressed mothers tend to simplify their

language with younger children to align with their developmental level, depressed mothers have been found to make fewer adjustments to their child-directed speech (Reissland et al., 2003). This difference in maternal linguistic adjustment has been posited to hinder children's access to learning-supportive child-directed speech (Kaplan et al., 2014). Depressed mothers have also been found to produce less speech during interactions with their children, compared to non-depressed mothers (Lovejoy et al., 2000). Reductions in the quantity of language produced by depressed mothers have been proposed to result from depressive symptoms, such as withdrawal and disengagement, which are likely to reduce speech production in general (Norris et al., 2016). Depression may also cause reductions in the speed of speech, with some individuals engaging in prolonged silences during conversation, which could also underlie lower rates of speech production among depressed mothers (Rowe et al., 2005).

Maternal depression has also been significantly linked with lower language quality, as indicated by mothers' vocabulary diversity (Rowe et al., 2005). However, other studies examining the impact of depression on mothers' language have reported no significant differences between the quantity or quality of language produced by depressed mothers versus non-depressed mothers (Brookman et al., 2020; Cornish et al., 2008), or mothers with a history of depression and controls (Murray et al., 1993). In Brookman et al.'s (2020) study, day-long home recordings were analysed for maternal speech, and no significant difference was observed in the quantity of speech produced by depressed mothers compared to non-depressed mothers with their 12-month-olds. However, the offspring of depressed mothers produced less complex language than their peers with non-depressed mothers (Brookman et al., 2020). Taken together, while research has consistently linked maternal depression to reductions in language quantity, there is less consensus regarding the impact that depression may have on maternal language quality.

Few studies have examined the influence that depression may have on fathers' language input with children, yet existing reports have provided evidence for negative associations between depression and fathers' language use with children. For example, Sethna and colleagues (2012) reported a significant association between paternal depression and fathers' increased use of speech that was self- rather than infant-focused during an interaction with their 3-month-olds. Depressed fathers were also found to use more negatively-valenced language when compared to non-depressed fathers. In a study examining the impact of paternal depression on fathers' speech during interactions with their 2-year-olds, Malin et al. (2012) found that the severity of fathers' depressive

symptoms was significantly linked to children's reduced language complexity (as indicated by lower mean length of utterance values). This effect was found to be partially mediated by the quantity and quality of language produced by fathers. While such findings support the view that paternal depression may significantly hinder fathers' ability to produce appropriate child-directed speech, further research that examines the impact of both parents' depression levels on their language use with children is required. For example, in one study conducted by Cabrera and colleagues (2007), fathers whose partners had higher self-reported depressive symptom severity produced less speech during dyadic interactions with their infants than fathers with non-depressed partners.

Evidence for the mediating role that responsiveness may play in the relationship between maternal depression and children's language outcomes has also been provided. In the NICHD Early Research Network longitudinal study (1999), children who had been exposed to chronic maternal depression, from infancy through to toddlerhood, obtained significantly lower expressive language scores. However, this effect was significantly mediated by observer-rated maternal responsiveness. Stein and colleagues (2008) reported similar findings; mothers' early parenting quality, including responsiveness, was found to significantly mediate the relationship between maternal depression and children's language outcomes (Stein et al., 2008). Further research is required to examine the potential mediating effects that both parents' responsiveness may have on the relationship between perinatal depression and children's language outcomes.

6.1.7 Fathers' potential compensatory role in child development

While paternal depression has the potential to adversely impact fathers' parenting quality, it is important to consider the important compensatory role that non-depressed fathers may play in the development of children exposed to maternal depression (Hossain et al., 1994; Vakrat et al., 2018). This buffering effect, brought about by supportive father-child interactions, may positively impact a wide range of child outcomes. For example, in Vakrat and colleagues' (2018) longitudinal study of maternal depression, 6-year-old children of mothers, who had experienced chronic depression from their child's infancy to their early childhood, were four times more likely to have a psychiatric disorder compared to their peers with non-depressed mothers. However, this risk was halved among children whose fathers were responsive.

Additionally, non-clinical research examining children's cognitive (Sethna et al., 2017), executive function (Towe et al., 2014) and language development (Pancosfar &

Vernon-Feagans, 2006; 2010) has provided evidence for the unique contributions that fathers may make to these developmental domains. Sethna and colleagues (2017) examined father-child interactions at 3 and 24 months postpartum. They found that children whose fathers displayed increased withdrawal during interactions at 3 months had significantly lower cognitive scores at 24 months. Conversely, fathers' responsiveness at 24 months was positively associated with children's higher concurrent cognitive scores, an association that held while controlling for maternal responsiveness (Sethna et al., 2017). In Towe-Goodman and colleagues' (2014) study, paternal responsiveness with their 2-year-olds was positively associated with their EF scores at 3-5 years of age. The impact of paternal responsiveness on children's subsequent EF was significantly greater than that of maternal responsiveness (Towe-Goodman et al., 2014).

In the language development literature, Pancsofar and Vernon-Feagans (2006; 2010) reported that the quantity and quality of language produced by fathers – and not mothers – during 2-year play interactions predicted children's expressive language outcomes at 3 years. These findings may be explained by the observed greater diversity of language that fathers tend to use with young children, compared to mothers (Bingham et al., 2013). While studies have reported a positive relationship between mothers' vocabulary diversity and children's age (Rowe et al., 2005), this association has not been reported in father samples, suggesting that fathers may produce more diverse language when interacting with young children compared to mothers (Bingham et al, 2013). Taken together, it appears that the influence of fathers may be particularly important in families affected by maternal depression, due to their potential buffering role, which may mitigate the adverse outcomes that have been associated with children's exposure to maternal depression.

6.1.8 Study outline

The current study sought to examine the impact of perinatal depression on the quality of parental input during play interactions. We also aimed to investigate the potential mediating effects that parental warmth, responsiveness and child-directed speech may have on the relationship between children's exposure to perinatal depression and their developmental outcomes at 2 and 3 years. The warmth, vocal responsiveness and language displayed by mothers and fathers was examined and compared by participant group at both timepoints. At 2 years, parents and children engaged in 5-minute structured play and 10-minute free play interactions, in dyadic (mother/father-child) and triadic

(mother-father-child) contexts. At 3 years, the laboratory protocol was condensed, and parents and children participated in 10-minute dyadic and triadic free play interactions. All parent-child interactions were video- and audio-recorded and transcribed, facilitating the current study's examination of associations between perinatal depression scores, parental input quality and children's outcomes. Based on prevalent findings in the literature, the following hypotheses were formed:

Hypothesis 1: Parental warmth and children's outcomes

Based on Hummel et al.'s (2015) study of maternal warmth and depression scores at 2 years postpartum, we hypothesised that parental warmth would be negatively associated with parents' current depression scores. Furthermore, we predicted that parental warmth would be positively associated with children's developmental scores at 2 and 3 years.

Hypothesis 2: Vocal responsiveness and children's outcomes

The odds of parents' vocal responses falling into the 'contingently responsive' category were hypothesised to be significantly lower among parents who had previous or current depressive symptoms, as indicated by antenatal depression status, and current depression scores. Furthermore, we hypothesised that mothers' vocal responsiveness would be positively associated with children's outcomes, and based on Tamis-LeMonda et al.'s (2004) findings, we predicted that fathers' responsiveness would be positively associated with children's cognitive, EF and language scores, while controlling for maternal responsiveness. In line with Marklund et al.'s (2015) findings, we hypothesised that greater parental responsiveness would be positively linked to children's vocabulary diversity. Finally, based on Stein et al.'s (2008) findings, we predicted that maternal depression scores would be negatively associated with children's language quality, and that this effect would be mediated by maternal responsiveness.

Hypothesis 3: Conversational balance and children's outcomes

Based on prevalent findings in the literature, we hypothesised that conversational turns would be negatively associated with parental depression scores. We predicted that conversational balance would be positively associated with children's language scores, and language quality. Furthermore, based on Gómez and Strasser's (2021) study of turn-taking at 18 months postpartum and offspring outcomes at 30 months, we predicted that conversational balance at 2 years would predict children's social-emotional outcomes at 3

years, while controlling for maternal warmth, children's 2-year social-emotional scores, and children's vocalisations.

Hypothesis 4: Parents' and children's language

In line with the consistently-reported link between parents' language quantity and depression, we hypothesised that these two variables would be negatively associated. There is less consensus in the literature regarding associations between parental language quality and depression. Furthermore, some researchers have proposed that depressed mothers tend not to adjust the difficulty of their language to align with their child's developmental level. Hence, we hypothesised that depression scores would not be significantly negatively linked to parents' language quality, based on the view that more depressed parents may use greater vocabulary diversity than non-depressed parents during a play interaction. Based on Cabrera and colleagues' (2007) findings, we predicted that mothers' depression scores would be negatively associated with fathers' language quantity. In line with Brookman et al. (2020) and Malin et al. (2012), we hypothesised that mothers' and fathers' depression scores would both be negatively associated with the quality of language produced by children. Finally, based on Pancsofar and Vernon-Feagans' (2006, 2010) findings, we hypothesised that fathers' language quality at 2 years would uniquely predict children's language outcomes at 3 years.

Hypothesis 5: Mediating role of HPA axis activity in children's language outcomes

The study outlined in Chapter 4 reported a significant link between maternal HPA axis activity and children's language development. Specifically, children whose mothers had a significantly lower cortisol awakening response (CAR) than the sample median had lower language scores compared to children whose mothers had a higher CAR. The current study will examine associations between maternal language and CAR, and test the potential mediating effect on the relationship between mothers' and children's language.

6.2 Method

6.2.1 Participants

Participating mothers were originally recruited through the Perinatal Psychiatry services and antenatal booking clinics of three maternity hospitals in Dublin: the National Maternity Hospital, the Coombe Women and Infants University Hospital, and the

Rotunda Hospital. Women who consented to participate, and met the study's inclusion criteria, were assessed by a research registrar in Psychiatry, and stratified into three groups: Depressed, History of Depression, and Control. Recruitment of mothers for the 2- and 3-year follow-ups was carried out by email and phone calls. Fathers were recruited at the 2-year timepoint by inviting mothers to assess their interest in participating and conducting follow-up phone calls to confirm whether the child's father would also be available to attend the appointment. The sample's demographic information was provided in Chapter 2.

6.2.2 Measures

Parental clinical measures

Parents were interviewed using the Hamilton Rating Scale for Depression (HAM-D; Hamilton, 1960) at 2 and 3 years. Both parents also completed self-report questionnaires, namely the Center for Epidemiologic Studies: Depression Scale (CES-D; Radloff, 1977) and the Perceived Stress Scale (PSS; Cohen et al., 1983), at both timepoints. Details for these measures were provided in Chapter 2.

Child developmental measures

At 2 years, the social-emotional, cognitive, language and general adaptive scales of the Bayley Scales of Infant Development-3rd Edition (BSID-III) (Bayley, 2006) were administered. At 3 years, the same BSID-III scales were used to examine children's outcomes, with the exception of the cognitive scale which was replaced by an Executive Function assessment, based on Willoughby and colleagues' (2010) battery of EF tasks. Details of these measures were provided in Chapter 2.

6.2.3 Parent-child interaction quality

The 2- and 3-year follow-ups took place in the TCD Infant and Child Research Laboratory. At both timepoints, parents and children engaged in a series of play interactions, which were video- and audio-recorded. Video recordings were captured by two Axis Q6035 PTZ Dome Network cameras, with 1080pixel resolution, 30 fps frame rate and 20x optical zoom, affixed to the laboratory walls, while audio was recorded using a BeyerDynamic MPC 66 V 12-84V microphone, connected to a XENYX 802 audio mixer, and concealed in the corner of the lab room. Parents were instructed to play with their child as they would at home. At the 2-year timepoint, parents engaged in dyadic and

triadic structured and free play interactions with their child. During structured play interactions, parents and children played with a wooden jigsaw, while a box of various toys was provided for free play. At the 3-year timepoint, only free play interactions were recorded. Full details of the materials used in each play context were provided in Chapter 2.

Parental warmth

The Parenting Interactions with Children: Checklist of Observations Linked to Outcomes (PICCOLO) affection subscale was used to rate the warmth displayed by parents towards their children, during dyadic free play interactions at the 2-year timepoint. Further details of this scale were provided in Chapter 2.

Parental vocal responsiveness

The dyadic free play interaction videos recorded at the 2- and 3-year timepoints were transcribed, audio-linked, and underwent sequential analysis, using General Sequential Quierier, version 5 (GSEQ-5; Bakeman & Quera, 2011). Sequential analysis can be used to identify patterns and temporal associations between observed behaviours, which facilitates the microanalytic examination of the contingency of timed sequences between parent and child vocalisations (Bornstein et al., 2015). The GSEQ-5 ‘window’ function was used to prescribe a 3-second window of opportunity following the offset of a child’s vocalisation, for a parent’s subsequent vocalisation to be categorised as responsive. A 3-second window was selected, based on the fact that many studies have reported “sensible and interpretable results with 3- or 5-second windows” (Bakeman & Quera, 2011, p. 137). The likelihood that a parent responded to their child within this 3-second window was assessed using GSEQ-5 table statistics, specifically Yule’s Q , which is an index of sequential association, based on a transformation of the odds ratio. Yule’s Q was selected to assess parental responsiveness as it controls for the base rate of the antecedent (child’s vocalisation) and target (parent’s vocal response) and is not influenced by the total number of vocalisations in an interaction (Bakeman & Quera, 2011).

Parents’ and children’s language

The language used by parents and children during play interactions was transcribed and analysed using Computerised Language Analysis (CLAN; MacWhinney, 2000). Prior to conducting analyses on the characteristics of this language, CLAN’s CHECK and MOR

utilities were used to confirm that transcripts were accurate and all words were in the correct morphological structure. Parents' language was coded for: total utterances, mean length of utterance (MLU) in words, vocabulary diversity (VOCD) and mean length of turn (MLT). Total utterances served as a measure for the quantity of parental language, MLU in words served as a measure for parental language complexity, vocabulary diversity (VOCD) served as an indicator for their overall language quality, and MLT measured the mean length of turn taken by each parent when conversing with their child. Children's language quantity was measured using total utterances, while the number of word types served as an indicator for the quality of children's language. Children's MLT was also computed, and child-parent MLT ratio was calculated by dividing a child's MLT by their parent's MLT; this ratio served as an indicator of conversational balance.

Inter-rater reliability

Parental warmth ratings were completed by a trained research assistant who was blind to the nature of the study. 20% of interactions were double-rated for warmth by the author. 20% of interactions used in the vocal responsiveness analyses were re-audio-linked by a research assistant who was blind to the nature of the study. Information regarding percentage agreement for warmth and responsiveness coding was presented in Chapter 2.

Missing and excluded interactions

At 2 years, there were four non-English-speaking mothers in the control group, and three in the history group, while there were also two non-English-speaking fathers in the control group. At 3 years, there were two non-English-speaking mothers in the control group and two in the history group, while there were two non-English-speaking fathers in the control group and one in the history group. Cases where recordings of English-speaking parents were not available for analysis were due to errors in laboratory protocol or technical difficulties in the recording process. At the 2-year timepoint, maternal warmth, responsiveness and language analyses were conducted on a sample of 39 mothers, and paternal analyses were conducted on a sample of 24 fathers. At the 3-year timepoint, maternal analyses were based on a sample of 30 mothers, while the paternal sample comprised 6 fathers.

6.2.4 Statistical analyses

In order to examine the first hypothesis, which predicted that parental warmth would be negatively associated with parents' depression scores, differences in the warmth displayed by mothers in each antenatal group were first examined using Kruskal-Wallis tests and corrected using Bonferroni tests for multiple comparisons. Kruskal-Wallis tests were conducted due to uneven group sizes. Due to a lack of linearity in the data, Spearman rank-based correlations were conducted to examine associations between parents' mood (HAM-D, CES-D and PSS) scores and their warmth ratings at both timepoints. Spearman-rank based tests were also used to examine associations among parents' warmth ratings and children's cognitive, language and adaptive scores at 2 and 3 years.

In order to examine the second hypothesis – that parents' vocal contingent responsiveness would be negatively associated with mothers' antenatal group and parents' current depression scores – the programme GSEQ-5 was used to compute Yule's *Q* values, which represented the likelihood that parents responded to children's vocalisations within a prescribed 3-second window of opportunity. Yule's *Q* transforms odds ratios so that all values range between -1 and +1, with a value of zero representing no effect (Bakeman & Quera, 2011). Due to uneven group sizes, nonparametric Kruskal-Wallis tests were used to examine group differences in parents' contingent vocal responsiveness. Due to a lack of linearity, Spearman rank-based tests were conducted to examine associations between parents' depression scores, Yule's *Q* responsiveness values and children's developmental scores.

In order to examine the third hypothesis – that conversational balance would be negatively associated with parental depression scores – we first calculated parents' and children's mean length of turn and then derived child-parent MLT ratios, to serve as indicators for conversational balance. We conducted Kruskal-Wallis tests to examine between-group differences in parent-child conversational balance, and used Bonferroni tests to correct for multiple comparisons. Due to a lack of linearity, Spearman rank-based tests were conducted to examine associations between mother- and father-child conversational balance, parents' mood scores and children's developmental scores. The fourth hypothesis predicted that parents' depression scores would be negatively associated with their language quantity, and that mothers' depression scores would be negatively associated with fathers' language quantity. Parents' language was examined in terms of quantity (total utterances), complexity (mean length of utterance [MLU] in

words), and quality (vocabulary diversity [VOCD]). Due to a lack of linearity, Spearman rank-based tests were conducted to examine associations between these language variables and parents' depression scores. We also hypothesised that parents' depression scores would be negatively associated with children's language quality, which was also examined using Spearman rank-based tests.

In order to test our hypothesis that fathers' language at 2 years would uniquely predict children's 3-year language outcomes, first, associations between fathers' language quality and complexity and children's language scores were examined using Spearman rank-based tests. A significant association was found between fathers' language complexity at 2 years and children's language scores at 3 years. The normality and linearity of these variables were assessed using a Shapiro-Wilks test and a QQ plot respectively. Following confirmation of these regression assumptions, a multiple linear regression was conducted, which tested the ability of fathers' language complexity at 2 years to predict children's language scores at 3 years, while controlling for maternal and paternal education, and mothers' language complexity.

Finally, in order to examine the association between maternal CAR and children's language outcomes reported in Chapter 4, Spearman rank-based tests were used to examine associations between maternal CAR and parenting quality. A mediation analysis, conducted using the PROCESS macro in SPSS, was used to test for an indirect effect of maternal CAR on the relationship between maternal depression scores and children's language outcomes. Confidence intervals were set at 95% and the significance level was set at 0.05 for all analyses.

6.3 Results

6.3.1 Perinatal depression scores and parental warmth

Descriptive data for maternal and paternal warmth are displayed in Table 6.1 below. At 2 years, maternal warmth ratings in the overall sample ranged from 9 to 14 out of a total possible score of 14, and paternal warmth ratings ranged from 7 to 13. At 3 years, warmth ratings ranged from 7 to 13 for mothers, and 10 to 13 for fathers. Due to uneven group sizes, Kruskal-Wallis tests were performed to examine group differences in the warmth displayed by mothers and fathers towards their children. No statistically significant group differences were found for maternal or paternal warmth at either timepoint. At 2 years,

the observed power, based on epsilon-squared effect sizes, was estimated at 19.9% for maternal warmth and 76% for paternal warmth. At 3 years, the observed power was estimated at 23.5% for maternal warmth and 38.7% for paternal warmth. Spearman rank-based tests revealed no significant associations between parental warmth and any measure of parental mood (HAM-D, CES-D or PSS) at 2 or 3 years. Mothers' and fathers' warmth ratings were positively correlated at the 2- ($r_s = .411$, $p < .05$, observed power = 72.3%), and 3-year timepoints ($r_s = .769$, $p < .05$, observed power = 81%).

Table 6.1

Descriptive data for parental warmth at the 2- and 3-year timepoints.

	Control		History		Depressed	
	M	SD	M	SD	M	SD
<i>2 years</i>						
Maternal warmth	11.10	1.25	11.65	1.32	11.50	1.38
Paternal warmth	10.69	1.80	11.09	1.92	12.00	0.50
<i>3 years</i>						
Maternal warmth	11.07	1.44	10.83	2.21	12.00	1.00
Paternal warmth	11.00	1.00	12.00	1.00	-	-

6.3.2 Perinatal depression scores and parental vocal responsiveness

Yule's Q values, representing the likelihood that parents responded to their children's vocalisations within 3 seconds, are displayed in Table 6.2. Kruskal-Wallis tests indicated no significant differences when the likelihood of parents' provision of contingent responses was examined by antenatal group (see Table 6.2). At 2 years, the observed power of this between-groups test was estimated at 61.6% for mothers' responsiveness and 20.2% for fathers' responsiveness. At 3 years, the observed power was estimated at 30.2% for mothers' responsiveness and 9.9% for fathers' responsiveness. Spearman tests indicated significant moderate negative associations between maternal depression scores and paternal responsiveness (observed power = 81%), and paternal depression scores and maternal responsiveness (observed power = 77.6%), at 2 years. Mothers' depression scores at the 2-year timepoint were also weakly associated with mothers' responsiveness at 3 years (observed power = 52.8%; see Table 6.3).

Table 6.2

The likelihood that parents provided contingent responses to their children, by participant group, at 2 and 3 years.

Timepoint	Odds of contingent responsiveness	Control	History	Depressed	Group comparisons
2 years	Mothers' Yule's Q	0.86	0.75	0.92	$H(2) = 5.29, p = .07$
	Fathers' Yule's Q	0.82	0.83	0.71	$H(2) = 0.89, p = .64$
3 years	Mothers' Yule's Q	0.83	0.81	0.74	$H(2) = 3.29, p = .19$
	Fathers' Yule's Q	0.95	0.71	-	$H(1) = 0.04, p = 1.00$

Table 6.3

Spearman correlation coefficients between parental depression scores and contingent responsiveness at 2 and 3 years.

Contingent responsiveness	Mothers' 2-year HAM-D	Fathers' 2-year HAM-D	Mothers' 3-year HAM-D	Fathers' 3-year HAM-D
<i>2 years</i>				
Mothers	-.207	-.478*	-.026	-.279
Fathers	-.564*	-.106	-.427	-.820
<i>3 years</i>				
Mothers	-.365*	.012	-.176	-.252
Fathers	-.439	-.610	-.402	.011

Note. * $p < .05$.

6.3.3 Perinatal depression scores and parent-child conversational balance

Descriptive data for parent-child conversational balance, as indicated by the ratios of child to parent mean length of turn (MLT) are displayed in Table 6.4. A child-parent MLT ratio closer to 1 indicates greater conversational balance, while a score closer to 0 indicates a talkative parent relative to the child.

Table 6.4

Descriptive data for conversational balance during dyadic free play.

Play context	Control		History		Depressed	
	Mdn	IQR	Mdn	IQR	Mdn	IQR
<i>2 years</i>						
C-M MLT ratio	0.46	0.37	0.36	0.43	0.39	0.34
C-F MLT ratio	0.49	0.24	0.63	0.54	0.72	0.38
<i>3 years</i>						
C-M MLT ratio	0.55	0.42	0.55	0.25	0.70	0.47
C-F MLT ratio	0.71	0.73	0.64	0.22	-	-

Note. C-M = Child-Mother; C-F = Child-Father; MLT = Mean length of turn.

Kruskal-Wallis tests indicated no significant group differences in parent-child conversational balance at 2 or 3 years. Spearman tests indicated that mother-child conversational balance was positively correlated with mothers' ($r_s = .565, p < .01$, observed power = 80.3%) and fathers' ($r_s = .583, p < .01$, observed power = 70.7%) current HAM-D scores at 2 years. Father-child conversational balance was also moderately correlated with mothers' HAM-D scores at 2 years ($r_s = .449, p < .05$, observed power = 56.5%). At 3 years, father-child conversational balance was positively associated with mothers' CES-D scores, $r_s = .762, p < .05$, observed power = 65.3%.

6.3.4 Perinatal depression scores and parents' language

Descriptive data for the language used by parents during dyadic structured and free play interactions at the 2-year timepoint are displayed in Table 6.5.

Table 6.5*Descriptive data for parents' language during structured and free play at 2 years.*

Play context	Language variable	Control		History		Depressed	
		Mdn	IQR	Mdn	IQR	Mdn	IQR
M dyadic STR	Total utterances	117	33.25	123	50	120	25.50
	MLU words	3.85	0.86	3.76	1.21	4.06	1.35
	VOCD	34.98	8.40	36.42	7.77	36.29	11.74
M dyadic FP	Total utterances	194.50	49.50	201	103	230	11.75
	MLU words	3.93	0.68	4.09	0.97	4.23	0.64
	VOCD	43.19	6.53	48.37	12.28	50.99	8.30
F dyadic STR	Total utterances	92.0	58.75	106.5	38.75	110.0	57.5
	MLU words	3.48	0.98	3.32	1.10	3.42	1.01
	VOCD	30.14	12.86	26.15	13.90	27.39	12.24
F dyadic FP	Total utterances	144	103.75	165.5	94.75	160.0	97.5
	MLU words	3.67	1.14	3.37	1.30	3.93	1.04
	VOCD	40.71	7.27	41.75	17.19	41.68	14.32

Note. M = Mother; F = Father; MLU = Mean length of utterance; VOCD = Vocabulary diversity.

Kruskal-Wallis tests indicated no significant between-group differences for the quantity (total utterances) or complexity (MLU in words) of mothers' language at the 2-year timepoint. Mothers' vocabulary diversity (VOCD) varied between groups, with mothers in the Depressed and History groups displaying higher diversity than Control group mothers. However, the significance of this difference attenuated following a Bonferroni correction for multiple comparisons. The observed power of this test was estimated at 59.11%.

Descriptive data for the language used during triadic mother-father-child play interactions at 2 years can be found in Appendix L. Kruskal-Wallis tests indicated that mothers in the Control group produced significantly more utterances than mothers in the History of depression group, during structured triadic interactions, $H(2) = 6.96, p = .04, \epsilon^2 = .41$, observed power = 66.5%. Fathers whose partners were in the History of depression group produced significantly more utterances during triadic free play than fathers whose partners had been in the Control group, $H(2) = -8.74, p = .02, \epsilon^2 = .33$, observed power = 53.3%.

Descriptive data for the language produced during dyadic and triadic free play interactions at the 3-year timepoint can be seen in Appendix L. No significant group differences were found for any aspect of parental language at this timepoint. Spearman's tests indicated that maternal depression scores were not associated with any aspect of mothers' language. Conversely, fathers' CES-D depression scores were negatively associated with the quantity and complexity of fathers' language (see Table 6.6).

6.3.5 Perinatal depression scores, parents' and children's language

Descriptive data for the language produced by children during dyadic interactions at 2 and 3 years can be seen in Appendix L. Kruskal-Wallis tests indicated no significant group differences for any aspect of children's language at the 2- or 3-year timepoints. At 2 years, observed power analyses for between-group Kruskal Wallis tests conducted to examine differences in children's language quantity, complexity and quality yielded estimates of 14.2%, 16.1% and 35.2% respectively. At 3 years, observed power for between-group tests for children's language quantity, complexity and quality was estimated at 9.4%, 44.9% and 31.9%. Spearman's rank-based tests indicated several statistically significant associations between parental depression scores, and parents' and children's language. At 2 years, mothers' and fathers' language quantity and complexity (as indicated by total utterances and MLU in words respectively), were positively

correlated (see Table 6.6). Children's language quantity (total utterances) was positively correlated with fathers' language quantity, complexity and quality (see Table 6.6). Children's language quantity and quality (number of word types) were both positively correlated with maternal and paternal HAM-D scores (see Table 6.6). Observed power of the association between children's language quantity and maternal HAM-D scores was estimated at 63.9% and the association between children's language quantity and paternal HAM-D scores was estimated at 70.5%. Observed power of the association between children's language quality and maternal HAM-D scores was estimated at 68.9% and the association between children's language quality and paternal HAM-D scores was estimated at 66.6%. At 3 years, there was a weak positive association between mothers' and children's language quality, $r_s = .334$, $p = .04$, observed power = 41.9%.

6.3.6 Parental postnatal input and children's developmental outcomes

Parental warmth

At the 2-year timepoint, fathers' warmth was positively correlated with children's Practical General Adaptive scores ($r_s = .410$, $p < .05$, observed power = 48.5%), and their GA composite scores ($r_s = .355$, $p < .05$, observed power = 34.3%). Maternal warmth was not significantly correlated with children's outcomes, and at 3 years, there were no significant associations between maternal or paternal warmth and any developmental domain.

Parental vocal responsiveness

No significant associations were observed between parental vocal responsiveness and children's developmental scores at 2 or 3 years. However, Spearman tests indicated a moderate association between children's language quality (word types) and maternal responsiveness at 2 years, $r_s = .652$, $p < .05$, observed power = 78.2%. Children's language quality was also significantly associated with maternal depression (see Table 6.6), although not in the negative direction that was hypothesised (observed power = 70.3%). A subsequent mediation analysis indicated that maternal responsiveness did not have a statistically significant indirect effect on children's language quality, as the model's 95% confidence intervals contained zero.

Parent-child conversational balance

Child-parent MLT ratios were examined as indicators of conversational balance during dyadic mother- and father-child free play interactions. Spearman tests indicated that there were significant positive associations between child-mother MLT ratios at 2 years and children's concurrent cognitive and language scores ($r_s = .543, p < .01$, observed power = 74.5% and $r_s = .645, p < .01$, observed power = 80%, respectively). There was also a significant association between child-father MLT ratios and children's social adaptive scores at 2 years, $r_s = .522, p < .05$, observed power = 67.7%. As the study outlined in Chapter 3 reported a significant positive association between maternal depression scores and children's social adaptive outcomes at 2 years, the potential mediating role of this factor was examined. However, a mediation analysis indicated that child-father conversational balance did not have an indirect effect on children's social adaptive outcomes at 2 years. At the 3-year timepoint, there were no significant associations between child-mother or father conversational balance and children's outcomes. Based on Gómez and Strasser's (2021) finding that greater turn-taking predicted subsequent offspring social-emotional outcomes, Spearman tests were used to examine conversational balance at 2 years and children's social-emotional scores at 3 years. However, no significant association was found.

Table 6.6

Spearman correlations for parental depression and parents' and children's language during dyadic free play at 2 years.

Study variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. M HAM-D	1													
2. M CES-D	.467**	1												
3. F HAM-D	.308*	.119	1											
4. F CES-D	.042	-.309*	.480**	1										
5. M T.U	-.018	.015	-.303	-.379	1									
6. M MLU-w	-.023	.012	-.290	-.396	.985**	1								
7. M VOCD	.342	.104	-.009	-.285	.395*	.384*	1							
8. F T.U	.141	-.051	-.197	-.544*	.676**	.696**	.132	1						
9. F MLU-w	.131	-.067	-.217	-.540*	.686**	.706**	.118	.989**	1					
10. F VOCD	.029	-.043	.043	-.027	.099	.112	.239	-.188	-.195	1				
11. C T.U (MC)	.435*	-.242	.467*	.192	-.203	-.065	.131	-.040	.082	.488*	1			
12. C T.U (FC)	.247	-.201	.227	.320	.114	-.045	-.172	-.053	.122	.027	.699**	1		
13. C W.T (MC)	.459*	-.123	.458*	.100	-.046	-.063	.309	.146	.121	.333	.333	.553*	1	
14. C W.T (FC)	.427	.008	.448*	.261	.229	.248	.310	.211	.192	.131	.131	.676**	.847**	1

Note. M = Mother; F = Father; C = Child; HAM-D = Hamilton Depression Rating Scale; CES-D = Center for Epidemiologic Studies Depression Scale;

T.U = Total utterances; MLU-w = Mean length of utterance in words; VOCD = Vocabulary diversity; MC = During mother-child interactions; FC = During father-child interactions; * $p < .05$; ** $p < .01$.

Parental language quantity, complexity and quality

At 2 years, maternal language quality was positively correlated with children's social-emotional and social adaptive scores (see Table 6.7). Maternal language quality was subsequently examined as a potential mediator in the relationship between maternal depression and children's social adaptive outcomes reported in Chapter 3. The results of this analysis indicated that maternal language quality did not have an indirect effect on children's social adaptive outcomes at 2 years.

There were no statistically significant associations between fathers' language quantity or quality and children's concurrent development. However, significant associations were observed between fathers' language complexity (as indicated by MLU in words) at 2 years, and children's language scores at 3 years, $r_s = .567$, $p < .05$, observed power = 76.1%. After the normal distributions and linearity of fathers' MLU in words and children's language data were confirmed, the hypothesised unique impact of paternal speech on children's subsequent language outcomes was tested using multiple linear regression. Fathers' language complexity at 2 years, as indicated by MLU in words, significantly predicted children's language scores at 3 years, while controlling for maternal and paternal education, and mothers' MLU in words, $R^2 = .41$, $F(23) = 8.26$, $p = .014$. A post-hoc power analysis estimated the observed power of this regression to be 55.2%.

At 3 years, maternal language quality was positively associated with children's social-emotional and general adaptive scores. There were no significant associations between fathers' language and children's concurrent outcomes at 3 years (see Table 6.8).

6.3.7 Maternal HPA axis activity, parenting quality and children's language outcomes

In order to investigate the negative correlation between maternal cortisol awakening response (CAR) and children's language outcomes reported in Chapter 4, this association was further examined by incorporating parental warmth, responsiveness and language data. However, Spearman rank-based tests indicated that there were no significant associations between maternal CAR and any aspect of parenting quality included in the current study.

Table 6.7*Spearman correlation coefficients for parental input quality and children's concurrent developmental scores at 2 years.*

Study variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. M warmth	1														
2. F warmth	.411*	1													
3. M Resp	.020	.458	1												
4. F Resp	.480*	.146	.266	1											
5. M T.U	.570**	.212	.432*	.165	1										
6. M VOCD	-.224	.274	-.015	.027	-.220	1									
7. F T.U	.287	.433	.155	.446	.099	.076	1								
8. F VOCD	-.262	.372	.191	-.226	-.194	.239	.247	1							
9. C SE	.108	-.071	-.036	-.029	-.064	.420*	.030	-.012	1						
10. C Cog	.048	.178	-.469	-.047	-.164	.190	.046	.356	.346*	1					
11. C Lang	-.134	-.003	-.391	-.407	-.424	.184	-.096	.156	.319*	.679**	1				
12. GA-C	.455	.260	-.083	-.090	-.030	.193	.052	-.161	.166	.450**	.601**	1			
13. GA-P	.076	.410*	-.025	-.189	.045	.264	.209	.136	.282*	.419**	.622**	.761**	1		
14. GA-S	.206	.280	-.214	-.181	-.003	.386*	.031	.002	.436	.246	.452**	.609**	.433**	1	
15. GA Comp	.132	.355*	.002	-.025	.055	.291	-.005	-.242	.190	.386**	.821**	.879**	.736**	.463**	1

Note. M = Mother; F = Father; C = Child; Resp = Responsiveness; T.U = Total utterances; VOCD = Vocabulary diversity; SE = Social-emotional; Cog = Cognitive; Lang = Language; GA = General Adaptive; GA-C = GA Conceptual; GA-P = GA Practical; GA-S = GA Social; Comp = Composite; * $p < .05$; ** $p < .01$.

Table 6.8*Spearman correlation coefficients for parental input quality and children's concurrent developmental scores at 3 years.*

Study variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. M warmth	1														
2. F warmth	.769*	1													
3. M Resp	-.006	.802	1												
4. F Resp	.775	.544	.021	1											
5. M T.U	.050	.400	.024	.024	1										
6. M VOCD	-.327	-.589*	-.142	.800*	-.193	1									
7. F T.U	.866	.500	-.494	.632	.205	.600	1								
8. F VOCD	-.571	-.462	-.500	-.400	.400	.022	.600	1							
9. C SE	-.160	-.211	.170	-.738	.020	.509**	-.348	-.261	1						
10. C EF	-.013	.308	-.129	.400	-.300	.193	-.714	-.751	.082	1					
11. C Lang	.217	-.051	.055	.632	-.334	.195	-.232	-.654	.021	.531**	1				
12. GA-C	-.177	-.549	-.188	.005	-.444	.576**	.377	.464	.546**	.528**	.395*	1			
13. GA-P	.083	-.632	-.105	.012	-.437	.547**	.551	.522	.337*	.481**	.297	.654**	1		
14. GA-S	.041	-.105	-.544	.872	-.083	.138	.232	.016	.175	.010	.059	.341*	.236	1	
15. GA Comp	-.057	-.833	-.349	.316	-.386	.550**	.3	.464	.409*	.500**	.346*	.827**	.815**	.562**	1

Note. M = Mother; F = Father; Resp = Responsiveness; T.U = Total utterances; VOCD = Vocabulary diversity; SE = Social-emotional; EF = Executive function; GA = General Adaptive; GA-C = Conceptual General Adaptive; GA-P = Practical General Adaptive; GA-S Social General Adaptive; Comp = Composite; * $p < .05$; ** $p < .01$.

6.4 Discussion

6.4.1 Parental warmth and children's outcomes

The first hypothesis sought to examine associations between parental warmth, depression and children's outcomes. The current study's null findings are not consistent with previous research that has provided evidence for a negative association between parental warmth and depression scores, and a positive association between warmth and children's outcomes (Baker, 2018; Hummel et al., 2016). Several characteristics of the study are likely to underlie these findings. First, sample attrition, which was particularly significant in the Depressed group, is likely to have hindered our ability to detect true group differences. Furthermore, the predominance of participants with mild or no depression at the final two timepoints led to the current study's dependency on evaluating depression using scores that indicate depressive symptoms, rather than caseness. This was likely to have contributed to the generally high levels of warmth displayed by parents.

The mean warmth ratings for parents across groups at both timepoints were high, and the range in ratings was narrow, with the largest observed in the 2-year paternal ratings, and the 3-year maternal ratings, which both ranged from 7 to 13 out of a total score of 14. However, the lack of significant associations between parental warmth and parents' current depression scores is an important finding. This lack of negative correlation supports the view that depression, particularly at low levels, may not significantly impede parents' ability to warmly engage with their children. Further research examining how various depressive symptoms may uniquely influence mothers' and fathers' warmth towards their children would further our understanding of how this aspect of parenting is impacted by depression.

6.4.2 Parental vocal responsiveness and children's outcomes

The current study's finding that mothers' depression scores were significantly associated with their subsequent vocal responsiveness is consistent with previous research that has reported lower responsiveness among parents with depression. Furthermore, the current study's reported cross-over associations between parents' depression and their partners' responsiveness are consistent with previous research (Goodman et al., 2011; Vakrat et al., 2018). Specifically, there were moderate negative associations between maternal depression scores and paternal responsiveness, and paternal depression and maternal responsiveness, at 2 years postpartum. Previous research has reported significantly lower

levels of responsiveness in non-depressed fathers who have a depressed partner relative to fathers who have a non-depressed partner (Goodman et al., 2011; Vakrat et al., 2018). Several theories may be relevant to these findings. According to ‘assortative mating’ theory, depressed women may be more likely to enter into relationships with less adaptive individuals (Marmorstein et al., 2004). Furthermore, it has been proposed that fathers may learn how to respond to their children from observing mothers, and reduced responsiveness associated with maternal depression may provide maladaptive modelling of caregiving behaviours to their partners (Feldman & Klein, 2003). Another possibility underlying the lower responsiveness among fathers whose partners have higher depression scores, is that attempting to compensate for perceived deficits in depressed mothers’ parenting is difficult to sustain overtime, particularly if a couple has several children to parent.

However, it is important to note that despite the negative correlations observed between parental depression scores and partners’ responsiveness, the current study reported no significant associations between maternal or paternal responsiveness and any aspect of children’s development. Hence, lower rates of responsiveness do not appear to have had a significant impact on children’s outcomes at 2 or 3 years. This finding is in line with Vakrat and colleagues (2018), who reported that while paternal responsiveness was indeed lower among fathers with a depressed partner, children’s risk of experiencing adverse outcomes was still significantly reduced, compared to those children who were exposed to significantly lower paternal responsiveness. Taken together, it appears that parents whose partners have depression may be less likely to engage in highly responsive parenting, compared to parents with non-depressed partners. However, individuals who are able to develop a responsive parenting style can play a major role in mitigating the adverse effects associated with depression and subsequent offspring outcomes.

6.4.3 Conversational balance and children’s outcomes

The positive associations between maternal and paternal depression scores and mother-child conversational balance found in the current study were not expected. Depressed mothers’ children have been reported to produce fewer conversational turns compared to their non-depression-exposed peers (Brookman et al., 2020). While the current study’s finding may be due to significant attrition among the more severely depressed participants, it is also possible that the greater conversational balance observed among

parents with higher depression scores and their children reflects children's repeated vocal attempts to gain a contingent response from a depressed parent. However, this is unlikely given that conversational balance during mother-child interactions was positively associated with children's concurrent cognitive and language scores at 2 years. Hence, increased conversational balance may have resulted from children's greater ability to engage in extended conversations, as reflected by their superior language scores. Furthermore, conversational balance during father-child interactions was positively associated with children's social adaptive scores at 2 years, which again, may reflect children's enhanced social skills, and ability to have extended conversations with their parents.

6.4.4 Parental language and children's outcomes

The current study's finding – that maternal depression scores were not associated with the quantity of language used by mothers – was contrary to our prediction. It is possible that mothers with higher depression scores did not display significantly reduced language production compared to non-depressed mothers due to the large proportion of the sample whose depression was mild. Mothers with low symptom severity are less likely to display the adverse parenting behaviours associated with depression, including reductions in speech (Prenoveau et al., 2017). Furthermore, the current study reported greater conversational balance among mother-child dyads with higher maternal depression scores. The enhanced social skills of children who have been exposed to depression, observed in the current sample, may also play a role in buffering the effect of depression on maternal language. Mothers may tend to produce more speech during interactions with children who have enhanced social skills, and a greater ability to extend conversations with their parents.

The lack of negative association between maternal depression scores and mothers' language quality, as indicated by vocabulary diversity, was predicted. While some researchers have reported a negative association between depression and mothers' language quality (Rowe et al., 2005), others have reported no association (Brookman et al., 2020; Cornish et al., 2008). Our hypothesis was informed by the latter research finding, as it has been proposed that depressed mothers may not adjust the difficulty of their language to align with their child's developmental level to the same extent that non-depressed mothers do (Kaplan et al., 2014). Hence, their language during interactions is likely to display equivalent, if not greater, diversity of vocabulary relative to non-

depressed mothers. Consistent with previous research (e.g. Malin et al., 2012), the current study found negative associations between fathers' (CES-D) depression scores and the complexity of their language at 2 years. This finding implies that fathers with higher depression scores produced less complex speech during play interactions. Based on Cabrera and colleagues' (2007) findings, we hypothesised that maternal depression scores would be negatively associated with fathers' language quantity. However, our null findings did not support this link, which indicates that in the current study, their partner's depressive symptoms did not affect the quantity of language produced by fathers.

Our finding that children's language quality was positively associated with mothers' and fathers' depression scores was not consistent with previous research (e.g. Brookman et al., 2020; Malin et al., 2012). This may be due to the fact that depressed parents who remained in the study at the final two timepoints largely displayed mild or moderate symptom severity. Any negative association between parental depression and children's language quality may be more marked in samples containing more severely depressed parents. The current study also sought to examine the potential unique influence that fathers may have on children's language development. The current study's identification of fathers' language complexity at 2 years as a significant predictor of children's 3-year language scores is consistent with Pancsofar and Vernon-Feagans' (2006, 2010) findings, which linked fathers' language quality with their children's subsequent language scores. This finding is important, as Pancsofar and Vernon-Feagans' findings were based on non-clinical samples, and replication of this finding in the current study underlines the important buffering role that fathers' input may play in the development of children exposed to maternal depression.

Due to the positive association, reported in Chapter 4, between maternal heightened cortisol awakening response and children's language scores, the current study examined whether this aspect of HPA axis activity may mediate the relationship between maternal depression scores and children's language quality. Our mediation analysis indicated that maternal CAR did not have a significant indirect effect on children's language outcomes. However, as this is the first study to examine associations between maternal CAR and children's language at 2 and 3 years postpartum, further research is required to examine associations between maternal depression, cortisol production, and children's language development.

6.4.5 Study strengths and limitations

The current study had several strengths, including the participation of fathers at the final two timepoints, which facilitated the analysis of parenting behaviours in both dyadic and triadic interactions, and the use of sequential analysis and Yule's Q , to examine parental vocal responsiveness at both timepoints. As Yule's Q is a transformation of the odds ratio, it is more useful for group comparisons, given its scale ranging from -1 to +1, compared to the odds ratio which can vary from 0 to infinity. Yule's Q also controls for the base rate of behaviours, which means that it can be used to compare contingent responsiveness across interactions containing varying amounts of speech. Another strength of the current study was the thorough examination of parents' and children's language quantity, complexity, quality and conversational balance at both timepoints. The level of detail examined across distinct categories of parental input differentiates the current study from research that relies on self-report measures to assess parenting quality. However, several limitations should also be noted.

First, the sample size at the final timepoints was significantly depleted, which limited the scope of our analyses. It is unfortunate, but predictable, that participants with more severe forms of depression were more likely to drop out, and that this reduced the likelihood of detecting true group differences. It is equally important to reiterate that while the current study's ability to detect group differences was reduced, the overall likelihood of significant spurious effects emerging, as a result of attrition and low power, was greatly increased. Hence, while the current study reported several significant findings, they must be interpreted with great caution. Large observational studies that are adequately powered will make a very important contribution to the literature examining perinatal depression and parent-child interaction quality across early childhood.

Additionally, while the responsiveness literature has primarily focused on parents' responses to children, researchers have also called for greater acknowledgement and examination of the agency that young children exert within their family interactions (Bornstein et al., 2015). Research that examines vocal responsiveness in a child-to-parent direction may further our understanding of the impact that parental depression may have on overall parent-child interaction quality. To the author's knowledge, no previous research has longitudinally examined both child and parent responsiveness in the context of perinatal depression. Existing research that has examined the influence of parental depression on children's responsiveness has reported lower responsiveness among infants of depressed mothers, compared to infants with non-depressed mothers (Field et al.,

2009); further research should examine this association across a longer term. Another limitation of the current study's responsiveness analysis was its sole measurement of parental vocal responsiveness in terms of promptness. Future research would benefit from examining parents' and children's responsiveness with regard to the semantic relevance of each speech partner's response to the previous utterance.

6.4.6 Conclusions

This study sought to contribute to the literature by examining relationships between perinatal depression, parenting quality, and children's outcomes at 2 and 3 years postpartum. The current study's null findings in relation to parental warmth and depression scores may be due to sample attrition. However, the lack of associations between warmth and current depression scores provides support to the view that parental depression at low levels, as indicated by low HAM-D and CES-D scores, may not significantly impact parents' ability to warmly engage with their children. Our finding that parents' depression scores were negatively associated with their partners' responsiveness was consistent with previous research. However, the lack of association between parental responsiveness and children's outcomes implies that parents' partners' depression did not adversely affect their responsiveness to a level that significantly impacted children's development.

The positive association observed between parental depression scores and conversational balance represents a novel finding in the current study. However, it is important to again consider the high likelihood that this finding may represent a statistical artefact brought about by the current study's small sample and significant power issue. Conversational balance was also positively associated with children's cognitive and language scores, which indicates that children whose mothers had higher depression scores displayed a greater ability to engage in extended conversations. Conversational balance was also positively associated with children's social adaptive scores. These findings should be interpreted with great caution due to the study's small sample, and should be further examined by large adequately powered studies.

We previously provided preliminary findings indicating that children who had been exposed to maternal perinatal depression had superior social adaptive scores compared to their peers with non-depressed mothers, and posited that this finding may represent children's resilience, arising from a more supportive postnatal environment. However, this chapter's findings give support to the view that the previously reported

positive association between maternal depression and children's adaptive outcomes was merely a statistical artefact that occurred due to low power. In the current chapter, no significant between-group differences were found for any aspect of parenting quality, aside from responsiveness which was significantly lower in both mothers and fathers the Depressed group. Hence, the current study provides no evidence that the children who were exposed to perinatal depression are being reared in more supportive contexts than their non-depression exposed peers.

Finally, the current study's identification of fathers' language complexity at 2 years as a significant predictor of children's 3-year language scores is consistent with previous research (Pancsofar & Vernon-Feagans, 2006; 2010). Replication of this finding in the current study supports the view that fathers may play a unique role in children's language development, which may be particularly important for children exposed to maternal depression.

Chapter 7
Discussion and Conclusions

7.1 Introduction

In this thesis, a prospective, longitudinal study was conducted to examine the relationship between perinatal depression, parental HPA axis activity, parenting and coparenting quality, and children's developmental outcomes at 2 and 3 years postpartum. Mothers were recruited during pregnancy and three participant groups were formed: Depressed, History of Depression and Control. Mothers and their infants participated in three follow-ups throughout the first postnatal year, and at the 2- and 3-year timepoints, fathers were also invited to attend follow-up appointments, based in the Trinity College Infant and Child Research Laboratory. The data collected at the final two timepoints were used to conduct the studies outlined in previous chapters. In this chapter, the main findings will be summarised and discussed in relation to their context within the existing literature. The strengths and limitations of the current study, as well as potential avenues for future research, will also be discussed.

7.2 Perinatal depression and children's developmental outcomes

In the current study, no significant group differences were observed for any aspect of children's development at 2 or 3 years. Furthermore, no negative statistically significant correlations were found between parents' current depression scores and children's developmental outcomes. These null findings suggest that mothers' antenatal depression status and parents' concurrent depression levels did not have a significant impact on children's social-emotional, cognitive or language development, as measured at these timepoints. However, it is very important to consider that the diminished sample size at the final study timepoints minimised our ability to detect group differences, and hence, may account for the lack of associations between depression scores and children's outcomes, reported in the current study. Additionally, it is important to consider the influence that the remaining sample's characteristics may have had on the current study's analyses, particularly the large proportion of parents who did not have depressive symptoms at the final timepoints.

As reported in Chapter 3, 65.6% ($n = 40$) of mothers at the 2-year timepoint had few or no depressive symptoms, as indicated by their HAM-D scores, and at 3 years, 47.62% ($n = 20$) of mothers had few or no depressive symptoms. At the 2-year timepoint, fathers' HAM-D scores indicated that 90.2% ($n = 37$) and at the 3-year timepoint, 80% ($n = 12$) of fathers had few or no depressive symptoms. This is important, as parents who have mild depression are more likely to maintain a supportive learning environment than

those who are severely depressed (Prenoveau et al., 2017). This is also relevant to the current study as parents' warmth and linguistic input were not found to be significantly associated with their current depression scores, which indicates their ability to maintain a supportive learning environment, associated with children's enhanced development. The influence of parenting quality on children's outcomes will be discussed later in this chapter.

An important contribution of the current study was the inclusion of children's adaptive behaviour as a developmental outcome measure. As far as the author is aware, the Adaptive Behaviour scale of the BSID-III – designed to evaluate children's daily life skills – has not been previously examined in the context of perinatal depression. Existing literature that has examined children's social adaptive functioning as it relates to parental depression, was conducted in older samples, and reported negative associations between children's exposure to depression and their subsequent adaptive outcomes. For example, in Kersten-Alvarez et al.'s study (2012), 5-7-year-old children of mothers who had experienced postnatal depression displayed less prosocial behaviour and were teacher-rated as less popular than their non-depression-exposed peers. Depressed mothers' adolescent offspring have also been reported to have less competent social skills and lower quality relationships compared to their peers with non-depressed mothers (Hammen & Brennan, 2003). However, no previous research has examined the social skills (as distinct from general social-emotional functioning) of depressed mothers' 2-year-olds.

One factor that was posited to underlie the current study's preliminary finding that depressed mothers' toddlers had superior social skills was resilience. Various conceptualisations of resilience have been used by researchers, including viewing resilience as a relatively stable trait (Connor & Davidson, 2003) or, as in the current study, as an outcome of positive adaptation (Luthar & Cicchetti, 2000). However, contemporary researchers favour a multisystemic model (Ungar & Theron, 2020; Masten et al., 2021). From this perspective, resilience may be defined as “the capacity of a dynamic system to adapt successfully through multisystem processes to challenges that threaten the function, survival, or development of the system” (Masten et al., 2021). From a developmental systems perspective, children continuously interact with various systems simultaneously, and the number of influential systems increases as a child's level of interaction with the outside world grows. From a transactional perspective (Sameroff, 2009), children also influence these systems, which emphasises the dynamic nature of children's development.

Individual factors that may support resilience include self-esteem and problem-solving skills (Bonanno & Burton, 2013; Schultz et al., 2009). Scultz and colleagues (2009) reported more resilient functioning among adolescents who had been exposed to early childhood maltreatment if they had greater problem-solving skills. Relational factors that may bolster resilience include positive relationships with caregivers and peers. For example, in a longitudinal study of individuals exposed to Adverse Childhood Experiences, Holmes and colleagues (2018) reported a more resilient academic trajectory among those whose caregivers provided more warmth. At the contextual level, communities that facilitate safe play and exploration of the neighbourhood may support children's positive outcomes (Sciaraffa et al., 2018).

In the current study, preliminary findings indicated no evidence that children who had been exposed to perinatal depression had poorer outcomes compared to children who had not been exposed to perinatal depression. This led to the hypothesis that the children in the current study may have exhibited resilience to their depression exposure, due to relational factors including high levels of parental warmth and responsiveness, which are associated with adaptive developmental outcomes. However, parents' rates of contingent responsiveness were ultimately found to be significantly lower in the Depressed participant group. Hence, the current study did not produce findings that were consistent with a multisystemic resilience model. Future adequately powered, longitudinal studies will greatly contribute to our understanding of resilience in the context of perinatal depression. From a multisystemic resilience perspective, interactions among various systems - including individual, family, school and community - may significantly influence individual functioning (Howell et al., 2021). Longitudinal research is imperative, as resilience should be not viewed as a static outcome, but rather one that may continuously change in response to interactions between the individual and the multiple systems in their environment (Masten et al., 2021). In the current study's context, future research of this kind may help to guide the timing of interventions during early childhood so as to yield the greatest positive outcomes for children and families affected by perinatal depression.

7.3 Parental HPA axis activity and children's outcomes

Contrary to our predictions, the current study found no significant associations between parental HPA axis activity and children's social-emotional, cognitive, EF and adaptive scores. However, a significant association between mothers' cortisol awakening response

(CAR) and children's language development was observed. The sample was grouped into median-based percentiles to examine differences in the outcomes of children whose mothers had significantly lower and higher CARs compared to the sample median. The children of mothers who displayed lower CARs, at the 25th percentile, had significantly lower language scores relative to their peers whose mothers' CARs fell at the 75th percentile. To the author's knowledge, this is the first study to examine the relationship between parents' HPA axis activity and children's language development. Given the significant associations that have been reported between parental depression and abnormal HPA axis activity, alongside parental depression and children's language outcomes, the current study's finding should prompt further examination of the potential factors underlying the association between maternal HPA axis activity and children's language outcomes.

7.4 Perinatal depression, coparenting quality and children's outcomes

The current study predicted that low ratings for observed coparenting quality would be negatively associated with children's outcomes for all developmental domains. However, no such associations were found for children's language or adaptive behaviour scores. The low proportion of severely depressed parents who remained in the final study timepoints likely underlies the lack of variation in parents' coparenting quality ratings. Parents with mild symptoms are less likely to exhibit the adverse coparenting behaviours associated with more severe forms of depression (Feinberg et al., 2003).

Based on the positive association between maternal depression and children's social adaptive development reported in Chapter 3, alongside Nandy et al.'s (2021) finding that undermining coparenting was linked to children's social adaptive deficits, the current study hypothesised that coparenting support would mediate the positive relationship between children's exposure to maternal depression and their social adaptive scores. However, no evidence for a significant indirect effect of coparenting support on children's adaptive scores was found. As Nandy and colleagues' (2021) non-clinical study was the first in the coparenting literature to examine children's adaptive outcomes, further research is required to examine the link between supportive and undermining coparenting and children's adaptive behaviour both in non-clinical and clinical contexts.

Future research would also be strengthened through consideration of various factors that may interact with depression to influence parents' perceived and observed coparenting quality. One key factor that underlies mothers' and fathers' attitudes and beliefs about how they may behave in family interactions is their parental identity

(Schoppe-Sullivan et al., 2021). Parents place varying degrees of importance on roles within the family, including provider, protector or nurturer; the roles that they most greatly identify with exert the most significant influence over their attitudes and behaviours (Palkovitz & Hull, 2018). For example, fathers who place great importance in their role as a provider are more likely to spend significant time at work compared to home, and focus on their family's finances, while spending less time with their family. This in turn may negatively impact their coparenting quality. For example, Kuo and colleagues (2017) reported greater undermining coparenting among dual-earner parents who demonstrated more traditional gender role attitudes. Conversely, fathers who predominantly identify with a nurturing role may engage in increased caregiving and more balanced coparenting, at times at the expense of providing financial support for the family. Schoppe-Sullivan and colleagues (2021) examined the impact of fathers' parenting beliefs on coparenting quality; structural equation modelling analyses indicated that fathers who reported stronger nurturing role beliefs during their partner's third trimester of pregnancy engaged in less undermining coparenting at 9 months postpartum.

Another important factor that influences coparenting and is traditionally associated with mothers is 'maternal gatekeeping' (Cannon et al., 2008). From this perspective, mothers can either encourage or discourage fathers' involvement in family interactions. Maternal 'gate closing' may manifest in criticism of the father's parenting, or engagement in other behaviours that actively discourage father involvement (Schoppe-Sullivan & Altenburger, 2019). In addition to reducing the rate and quality of father-child interactions, increased maternal gatekeeping is also associated with fathers' engagement in less supportive coparenting behaviour (Schoppe-Sullivan et al., 2021). Little research has examined the impact of maternal gatekeeping on coparenting in the context of depression. However, one recent study examined links between fathers' perceptions of maternal gatekeeping, fathers' reported adherence to masculine norms, and their self-reported depression severity (Thomas & Holmes, 2020). Fathers who reported experiencing greater maternal gatekeeping also reported higher levels of depression. This association was moderated by fathers' adherence to masculine norms, with those rating themselves higher in masculinity reporting higher levels of gatekeeping and depression. While gatekeeping behaviours are widely considered maladaptive, the authors posited that their findings indicate a protective function for children that gatekeeping may play in families exposed to higher levels of paternal depression and adherence to masculine norms (Thomas & Holmes, 2020).

To the author's knowledge, only one study has examined associations between mothers' perinatal depressive symptoms and maternal gatekeeping. Schoppe-Sullivan and colleagues (2015) reported a significant association between mothers' self-reported depression severity during pregnancy and their self-reported engagement in gate closing behaviours at 3 months postpartum. Further research is required to examine this association in greater detail. Schoppe-Sullivan et al's (2015) study was based on self-report measures, and examined gatekeeping at 3 months only. Father involvement is widely reported to increase significantly as infants progress into toddlerhood. Hence, future research that examines the impact of perinatal depression on mothers' gatekeeping behaviours and how gatekeeping may impact parents' perceived and observed coparenting quality, should be conducted over a longer period of early childhood. Furthermore, future studies would benefit from the inclusion of an observational measure of gatekeeping behaviours, as parents' self-report measures may not yield accurate information on coparenting quality among families impacted by depression.

7.5 Perinatal depression, parenting quality and children's outcomes

Contrary to our hypothesis, parental warmth was not associated with parental depression scores in the current study. Low power, as well as the predominance of participants with mild or no depressive symptoms at the final timepoints, likely influenced the generally high warmth ratings observed in the current study. Consistent with previous research, maternal depression scores were found to negatively correlate with mothers' subsequent vocal responsiveness. Furthermore, significant cross-over effects were observed, wherein parents' vocal responsiveness was negatively associated with their partners' depression scores. This finding is consistent with previous research that has reported lower responsiveness among non-depressed fathers whose partners are depressed, compared to their peers with non-depressed partners (Goodman et al., 2011; Vakrat et al., 2018). Another finding of the current study that is consistent with Vakrat et al. (2018) is that despite the existence of negative associations between parental depression scores and parental responsiveness, no significant associations were found between responsiveness and any developmental domain. This implies that parents with depressed partners who display lower responsiveness than parents with non-depressed partners, may still play an effective buffering role for children exposed to depression. Vakrat and colleagues (2018) reported that while paternal responsiveness was lower among fathers partnered with depressed mothers, the likelihood of their children experiencing adverse outcomes was

still significantly reduced compared to children who were exposed to maternal depression combined with significantly lower paternal responsiveness.

Finally, further support for the unique role that fathers may play in children's development was observed in their language use during free play interactions. Fathers' language complexity at 2 years was found to significantly predict children's language scores at 3 years. This finding is consistent with Pancsofar and Vernon-Feagans' (2006; 2010) research, which linked fathers' language quality with their children's subsequent language scores. This represents a particularly important finding from the current study, as Pancsofar and Vernon-Feagans' studies were based on non-clinical samples. The current study's replication of their findings emphasises the important role that fathers may play in mitigating the adverse outcomes associated with exposure to maternal depression. Future language research with large samples, containing a greater number of depressed mothers and fathers, would further our understanding of the compensatory role that fathers may play in the area of children's language development.

7.6 Study strengths and limitations

The studies presented in the current thesis report several novel findings that contribute to existing literature examining perinatal depression and children's developmental outcomes. The lack of negative associations between previous or current parental depression scores and children's outcomes across developmental domains demonstrates the adaptive resilience that young children who have been exposed to depression can exhibit. To the author's knowledge, the current thesis presents the first study to examine toddlers' adaptive development in the context of perinatal depression. Hence, our finding that depressed mothers' offspring had superior social adaptive outcomes at 2 years is important and should prompt further research in this area. The overall lack of negative association between depression scores and parenting quality also demonstrates the resilience of parents during a particularly demanding period of their child's development. Furthermore, the unique influence that fathers' language was found to have on children's subsequent language outcomes provides evidence for the compensatory role that fathers may play in families affected by maternal depression.

The studies described in this thesis have several strengths. The prospective design facilitated the collection of rich mood-related and developmental data from mothers and their children at each timepoint. The inclusion of fathers at the 2-year timepoint also enabled the comparison of parenting behaviours between groups and partners, as well as

the examination of observed and perceived coparenting quality which is a novel facet of the current study. The baseline recruitment process represents another strength of the foundational study upon which the current thesis is based. Mothers were recruited to the Depressed group by a research registrar in Psychiatry, who conducted diagnostic interviews to evaluate their depression severity. This is in contrast to larger studies' predominant use of self-report questionnaires for the stratification of samples.

Another strength of the current study was the observation of parent-child play interactions in the TCD Infant and Child Research Laboratory. The laboratory was designed to promote naturalistic behaviours, with brightly-coloured décor, discreet wall-mounted cameras and a wide range of toys. The laboratory setting also enabled environmental stimuli to be controlled across all participants, which facilitated direct comparisons between interactions (De Barbaro et al., 2013). Furthermore, children's cognitive and language outcomes were evaluated through direct assessment, using standardised measures. The video and audio recordings captured in the Infant and Child Research Laboratory facilitated the detailed examination of parent-child interactions.

Dyadic and triadic play interactions were transcribed verbatim, and the sequential analysis method used to investigate parental vocal responsiveness has several advantages over other commonly used methods. Sequential analyses are more accurate than the examination of correlations between rates of behaviours, as the contingency of timed sequences between children's vocalisations and mothers' responses can be examined at a microanalytic level (Bakeman & Quera, 2011). Timed-event sequential analysis enables the capturing of the complex, dynamic back-and-forth that occurs during parent-child interactions (Bornstein et al., 2015). Another strength of the current study was the thorough examination of parents' and children's language quantity, complexity, quality and turn-taking at both timepoints. To the author's knowledge, this was the first study to examine the conversational balance exhibited during both mother- and father-child play interactions at 2 and 3 years, in the context of parental depression. The observational and micro-analytic methods used to examine the language produced and conversational quality exhibited during dyadic and triadic interactions distinguishes the current study from most previous perinatal depression research that has largely relied on parenting behaviour questionnaires.

However, several limitations should also be noted. First, significant attrition occurred prior to the final timepoints, and hence, the sample size was small, which greatly limited the scope of our analyses. It is widely known that low power, resulting from a

small sample, significantly impedes a study's ability to detect real effects. However, it is also the case that low power decreases the likelihood that statistically significant effects found are true effects (Fraleley & Vazire, 2014). Given the significant attrition that occurred in the current study and its low power, it is very important to consider all reported significant findings with great caution. Firstly, the positive associations that were reported between children's adaptive behavioural scores and mothers' depression measured antenatally and at child age 2 years may have been statistical artefacts rather than novel findings. This reported association, is particularly important to consider with extreme caution considering that this was the first study to examine this aspect of development in a sample of children exposed to perinatal depression. Another significant result reported in the current study that should be interpreted prudently is the negative association reported between maternal Cortisol Awakening Response and children's language scores. Again, this relationship has not been previously examined in the literature and is likely to represent a spurious finding, resulting from the study's low power. Adequately powered research is greatly needed to examine children's adaptive behavioural outcomes, and general developmental outcomes in the context of perinatal depression and parents' HPA axis activity. Another significant finding reported in the current study that likely constituted a statistical artefact was the negative association found between parents' observed coparenting supportiveness and children's cognitive scores. This was in direct contradiction with the positive association between supportive coparenting and children's cognitive outcomes that has been widely reported by large studies in the literature (Feinberg et al., 2007; Cabrera et al., 2012).

Despite the advantages of laboratory-based observational research, this setting may have lower ecological validity than observations made in a child's home environment. For example, comparisons of parental language used during hour-long and day-long video recordings indicate that a more concentrated sample of language may be derived from brief recordings, and hence, may result in an inflated measure of the parental language that a child is exposed to on a daily basis (Bergelson et al., 2019). However, the use of brief recordings is common in the literature and facilitates microanalytic analyses of parents' and children's behaviours.

Another weakness related to the current study's analysis of parenting behaviours was the sole measurement of parental vocal responsiveness in terms of promptness. The semantic contingent responsiveness, which measures the relevance of a parent's vocalisation to their child's previous utterance, is considered equally important to

children's outcomes (McGillion et al., 2013), and hence, the omission of microanalysis for the content of children's and parents' vocalisations represents a weakness of the current study.

Participants' completion of salivary samples at home represents another limitation of the current study, as sampling error may have been introduced to our cortisol analysis. Potential errors may have occurred from eating or drinking prior to sample collection, and collecting samples at incorrect times. Furthermore, the cortisol awakening response (CAR) has been shown to vary significantly depending on an individual's duration of sleep the night before sampling (Aubry et al., 2010), and the day of week on which it is measured (Kunz-Ebrecht et al., 2004). Hence, the current study's once-off measurement of parents' CARs, and inability to control for the day that samples were collected, represent further weaknesses of the study.

Another limitation related to the study's saliva sampling process was the laboratory-based baseline cortisol measure obtained from children. While laboratory-based saliva sampling has been widely used in early childhood research, Valentino and colleagues (2017) proposed that at-home baseline salivary cortisol sampling can be facilitated through researchers' thorough in-person explanation and modelling of saliva collection for participants. Strategies that may support parents' accurate sampling of their children's saliva include phone call reminders, and a log book for participants to record the time of collection. In a recent study of toddlers' midday cortisol levels, Wesarg and colleagues (2022) analysed saliva samples collected by parents at home. Parents collected their children's saliva samples for two days and the results indicated that children's baseline cortisol levels were comparatively higher on the first day. The baseline sample on the first day was collected immediately after the researcher had demonstrated how to use the saliva swabs. The authors hypothesised that this higher baseline measure was likely due to a stress response induced by the presence of the researcher. Taken together, these findings suggest that research examining young children's stress reactivity may be strengthened by facilitating at-home baseline saliva collections completed by parents, following extensive explanation and demonstration, on a different day to the agreed testing date.

7.7 Theoretical and practical implications of the current findings

The current thesis expands on literature examining the impact of perinatal depression on children's outcomes. Our findings derived from the analysis of triadic interactions have theoretical implications that may guide future research. Many previous studies examined associations between parental depression and children's development using cross-sectional designs, and the majority of research has omitted fathers and in-depth analyses of dyadic and triadic parent-child play interactions. The significant negative association between maternal depression scores and fathers' perceptions of the coparenting relationship, as well as the negative association between parents' vocal responsiveness and their partners' depression scores reported in the current study, provide support for the adoption of a systemic view of the family in which research examines both dyadic and triadic family processes.

From a family systems perspective (Minuchin, 1974) in order to capture the dynamic nature of a family, it is important to simultaneously examine the caregiving behaviours of both parents when investigating the influence that perinatal depression may have on children. Regardless of which parent is depressed, both parents' caregiving may be significantly influenced. Further longitudinal research that examines various aspects of family dynamics in tandem – for example, marital quality, observed and perceived coparenting, and partner-directed language – may elucidate the relative influence of factors moderating the relationship between a parent's experience of depression and their partner's or their own subsequent parenting quality.

The findings presented in the current thesis also have practical implications for family therapy and intervention. In the perinatal depression literature, research has informed the creation of several preventive interventions that are designed to enhance maternal perinatal mental health. However, few have been designed for use with both mothers and fathers, and scant interventions have been found to successfully ameliorate parental depression severity while simultaneously improving children's outcomes. Current evidence suggests that CBT-based perinatal interventions may have significant positive effects on maternal mood (Sockol, 2015). However, a meta-analysis conducted by Cuijpers and colleagues (2015) reported significant variability across studies with regard to the efficacy of such interventions in enhancing depressed mothers' children's outcomes. For example, in Forman et al.'s (2007) study, effective treatment of maternal postnatal depression was not associated with improvements in children's internalising or externalising difficulties at 18 months. Hence, in order to effectively

minimise the negative impact that depression can have on children, an integrated approach that combines depression- and parenting-targeted interventions should have a greater positive impact on children's long-term developmental outcomes.

One intervention that has been associated with positive outcomes for depressed mothers' toddlers and preschool-aged children is Triple P (Positive Parenting Program; Sanders et al., 2000). Enhanced Triple P was designed to teach CBT techniques and parenting skills to depressed mothers, with the aim of managing their depression and enhancing parenting (Sanders et al., 2000). A meta-analysis examining twelve studies with diverse ethnicities demonstrated that Enhanced Triple P was associated with mothers' increased adjustment, improved parenting and better social and behavioural outcomes for children. Follow-ups indicated that mothers who had participated in Enhanced Triple P displayed even greater adjustment and parenting quality over time (Sanders et al., 2014).

The trajectory of depression severity observed in the current study's sample provides support for the use of regular follow-ups in the implementation of interventions. While the control group mothers' HAM-D depression scores peaked at 2 years postpartum, mothers who had antenatal depression or were euthymic during pregnancy with a history of depression displayed steady increases in their median depression scores from 1 to 3 years postpartum. If future longitudinal research with larger samples replicated this finding, it would provide support for the view that mothers who had depression prior to or during pregnancy should not be considered particularly vulnerable to depression in the first postnatal year only, but rather should be considered to be at heightened risk of recurrent episodes throughout the early childhood years. This finding may inform interventions, as it suggests that consistent follow-ups with mothers who have a history of depression may be important in screening and providing appropriate support to mothers and their children throughout early childhood. The importance of maintaining contact with depressed mothers who have engaged in parenting interventions has been explored through the use of annual question-and-answer exchanges and assessments with feedback, which have shown evidence of efficacy in maintaining positive parenting outcomes (Breitenstein et al., 2015).

Interventions that have been specifically designed to improve fathers' perinatal depression are scant, and existing studies have reported little or no success in significantly reducing paternal perinatal depressive symptoms (Goldstein et al., 2020). As existing paternal depression interventions are based on findings derived from research with

depressed mothers, future research should seek to clarify the most influential factors that contribute to paternal perinatal depression specifically. Researchers have questioned the validity of using typical self-report depression measures with men, as they have been posited to underdiagnose male depression (Baldoni & Giannotti, 2020). Due to psychosocial factors, men generally have a higher likelihood of displaying depression through externalising symptoms compared to women, which are not thoroughly assessed through traditional self-report measures of depression severity (Seidler et al., 2016). Paternal perinatal depression can differ significantly from maternal perinatal depression in terms of presentation and intensity (Baldoni & Giannotti, 2020). Hence, future research should consider potential differences in mothers' and fathers' experiences of perinatal depression and examine the ways in which distinct strategies may enhance the effectiveness of interventions across parents.

The current study's findings that fathers' vocal responsiveness was negatively associated with maternal depression underlines the importance of including fathers in any intervention designed to improve depressed parents' parenting. Even fathers who do not display depressive symptoms may display significantly lower responsiveness in families affected by maternal depression (Vakrat et al., 2018). Our finding that fathers' language complexity uniquely predicted children's subsequent language scores indicates that fathers may play an important buffering role for children exposed to maternal depression. This finding adds further support to our view that all future perinatal depression interventions should adopt an integrative model that includes both parents, and guides them toward parenting behaviours that are associated with children's enhanced outcomes and positive family functioning.

7.8 Future directions

There is a lack of consensus in the literature with regard to the impact that perinatal depression has on children's subsequent developmental outcomes. While the social-emotional domain in particular has undergone extensive investigation, comparatively less research has examined children's cognitive and language outcomes using longitudinal designs that span the perinatal period through to early childhood. Furthermore, to the author's knowledge, our study examining children's adaptive behavioural outcomes was the first to examine this developmental domain in the perinatal depression literature. Further studies that are adequately powered are required to investigate the impact of maternal and paternal perinatal depression on children's outcomes and their parenting

behaviours, and how the quality of these behaviours may mediate the relationship between children's exposure to depression and their subsequent development.

Future perinatal depression observational research would benefit from consideration of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement. The STROBE statement aims to provide guidelines for how to report observational research clearly, and led to the formation of checklists containing the key elements to consider when carrying out observational research. Two elements that would have improved the current study's quality would have been to: 'Describe any efforts to address potential sources of bias' and 'Explain how the study size was arrived at'. A significant potential source of bias in the current study was the attrition that occurred, resulting in a very small sample size. While significant efforts were made to minimise attrition in the current study, continuous consideration of the STROBE statement may have prompted increased efforts to develop more effective participant retention strategies for the final two timepoints. Use of the STROBE statement in this way would have also improved the study's reporting quality, as a larger sample would have facilitated the use of more sophisticated statistical analyses, and increased our ability to compare findings with other studies.

Research that contains large enough samples to compare parents by their depression severity at each timepoint is important, as perinatal depression should be examined in terms of symptom chronicity and severity. In large longitudinal samples, this type of comparison can be done using techniques such as group-based trajectory modelling (Brennan et al., 2000; Prenoveau et al., 2017). This research design is imperative for furthering our understanding of the relationship between parental depression and children's outcomes, as existing research has provided evidence for an increased likelihood of social-emotional deficits among children whose parents have both severe and persistent perinatal depression (Brennan et al., 2000; Prenoveau et al., 2017). While existing research using trajectory modelling of depressive symptoms has increased our understanding of the impact of parental depression on children's social-emotional functioning, further research that uses trajectory modelling should assess a wider range of children's developmental outcomes, alongside parenting behaviours that may mitigate the effects of children's exposure to parental depression.

The lack of diversity, particularly in relation to ethnicity, observed in the current sample, represents a significant issue in the literature. Research suggests that factors including stigma, lack of trust, logistical barriers and a lack of culturally aware

researchers may all contribute to the recruitment of samples that predominantly constitute the dominant ethnicity, which is not representative of the overall population (Sugden & Moulson, 2015). Based on a systematic analysis of barriers to recruiting ethnically diverse samples (Brown et al., 2014), Waheed and colleagues (2015) described several strategies that researchers may adopt to enhance recruitment and retainment of participants of different ethnicities.

Strategies that may support recruitment of a more diverse sample include planning outreach activities with the target community, e.g., distributing brochures related to depression, and speaking on local radio about the study. Another strategy which can aid recruitment is the involvement of a ‘culturally competent person’, who is defined as an individual who has the same ethnicity as prospective participants (Chen et al., 2005). A researcher who does not have the same ethnicity as the target population but can speak their language fluently can also support recruitment (Waheed et al., 2015). Lack of trust in research is a major barrier in recruitment, which may be addressed through researchers’ engagement with multiple community organisations. Waheed et al. (2015) suggested that researchers may contact community health advisors who can help to inform individuals about the study. Aliyu et al. (2006) linked geo-coding and census data to digital maps to visualise ethnic minority populations which enabled the researchers to select medical settings that were situated in areas that served a greater proportion of ethnic minority groups than other medical settings.

Another strategy that may support recruitment of more diverse samples is the use of online self-referral as well as medical referral. In a randomised controlled trial of an online parenting intervention designed to improve mothers’ mood and infants’ outcomes, Baggett and colleagues (2020) reported that the rate of maternal self-referral was 3.5 times greater than community agency or research staff referral. Mothers who self-referred had higher levels of risk than mothers who had been referred by others, as indicated by their Patient Health Question-9 (PHQ-9) responses. Such findings indicate that online self-referral may support greater recruitment among groups whose participation may be typically hampered by various logistical, financial and stigma-related factors they face during traditional recruitment practices. This includes individuals from ethnic minority groups as well as more severely depressed individuals.

Further research is needed to examine the relationship between parental depression and observed and perceived coparenting quality. Prior to the current study, Tissot and colleagues (2016; 2019) were the first to report a negative association between

maternal depression scores and observed coparenting cooperation, and no association between paternal depression scores and coparenting quality. Hence, further research is required to validate their findings. This is particularly important given that non-clinical research examining family dynamics has provided evidence for the greater influence that dynamics, including marital quality, appear to have on fathers' involvement with their children relative to mothers (Lamb, 2004). As such research implies that fathers' parenting behaviours may be more susceptible to the quality of family dynamics, further research should examine the specific aspects of maternal and paternal depression that present as risk factors for low coparenting quality.

Furthermore, future research should examine the bidirectional effects of parents' and children's behaviours in the context of perinatal depression. While most of the developmental literature has examined the impact that parents have on children, it is important to recognise the agency that young children exert within their family interactions. Future longitudinal research should consider the impact that children's temperament and behaviours may have on mothers' and fathers' depression severity, and overall parent-child interaction quality. For example, researchers in the responsiveness field have begun to also examine vocal responsiveness in a child-to-parent direction (Bornstein et al., 2015). By considering the reciprocal nature of parent-child interactions, we should gain a deeper insight into the impact that exposure to parental depression may have on family dynamics and children's development.

7.9 Conclusions

This study presents novel findings that should be interpreted with caution due to low power, which increased the likelihood of detecting significant spurious effects. While power was a significant issue, a wide range of parenting and child outcomes were examined, and our findings should prompt further longitudinal observational research of these aspects of parent-child interaction using large samples. Recruitment for longitudinal early childhood research, particularly in a clinical context, may be considered challenging, time-consuming and expensive. However, the reporting of significant effects by inadequately powered studies, alongside a publishing bias that favours significant results, represents a significant issue in the field (Oakes, 2017). The design of strategies that effectively increase recruitment and retention of participants is required. While this process may involve significant investment of time and finances, the literature will reap significant gains, in the increased validity of reported findings, and hence, a greater

understanding of the complex relationships that exist between perinatal depression, parent-child interaction quality, and children's developmental outcomes.

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Appendices

Appendix A. Information Sheet



Infant and Child Research Lab
Trinity College Dublin



Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Parent – Child Interaction Study Information Leaflet

Infant & Child Research Lab
School of Psychology
Áras an Phiarsaigh
Trinity College
Dublin 2

This leaflet provides information on the research study and aims to answer any questions you may have.

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Who are we?

We are lecturers and researchers in the School of Psychology and School of Psychiatry, Trinity College Dublin. In our Infant and Child Research lab, we study parent-child interaction and its contribution to infant and child development.

Why am I being asked to participate in this research project?

You have been asked to take part in this research project based on your previous participation in the '*Depression during pregnancy: A study of stress hormone systems in women and their babies*' research study. At the first three time-points of this study (2, 6 and 12 months), both you and your baby provided some saliva samples, took part in developmental assessments and a short video was recorded where both of you interacted and played together. When your child reached 24 months, both parents were invited to participate in a follow-up based in the TCD Infant and Child Laboratory, in which developmental assessments and videos of you and your child interacting were recorded again. We would like to further our understanding of the relationships and interactions between parents and their children in situations where mothers have experienced variable levels of stress or depression during pregnancy. We want to find out what features of parent-child interaction are most important for infant and child development. We would also like to take a further look at mothers', fathers' and children's stress response systems at 36 months.

What is the research about?

In our research studies, we observe, record and analyse in detail how children and their parents react and respond to each other when interacting, and how these patterns of interaction relate to aspects of child development. For example, we know that the way adults typically respond to babies' babbling aids language development. Even very young babies actively participate in, and initiate interaction with, their parents and other family members and – using video observation tools – we study this behaviour in detail. This type of approach assumes that parents and children influence each other such that parents' behaviours shape children's behaviours which, in turn, have an effect on parents' behaviours.

The information collected at the 36-month follow-up will be collated with the information from previous study time-points (2, 6, 12 and 24 months), and enable us to examine changes in children and their parents over a longer time period. The information gathered at 2, 6 and 12 months has been analysed and used to explore various research questions so far. A recently-published article in *Early Human Development* was based on the results of this analysis, and examined the impact of mothers' antenatal depression on infants' cognitive, language and motor development at 6 and 12 months post-partum (O'Leary et al., 2019). As we have since broadened the scope of the study to include fathers' questionnaire- and observation-based information, we aim to investigate differences in parents' style of interaction, and how changing contexts (e.g. structured play versus free play, and parents' partner presence versus absence during play) may impact the quality of interaction observed among children and their parents. We will also be able to explore the impact that fathers' postpartum stress or depression may have on children's development and overall family functioning.

We would also like to look at mothers', fathers' and children's stress hormone systems at 36 months, by measuring the amount of the stress hormone, cortisol, in a saliva sample. Additionally, stress can change the way that some genes work. This process is called epigenetics and this can also be measured in saliva. We would like to look for any differences between mother and child in a specific gene at 36 months.

What will the research involve?

To explore these questions, mother, father and child (34-38 months) will be asked to visit our lab and to interact and to play together in our playroom just as you would at home. We are interested in studying the kinds of games, activities and ordinary conversational interactions that families engage in at home every day.

Specifically, your participation in a study will involve one visit to the lab in TCD lasting no longer than 3 hours, during which you will be with your child at all times. Mother and father will be asked to provide some information about yourselves and your family, and

to complete a short language assessment and some questionnaires, for instance, on your stress levels, your parenting styles and beliefs, your child's temperament. In addition, a researcher will administer short age-appropriate cognitive and language ability tests to your child. Then we wish to simply observe you and your child interacting and playing as normal for a short period. This will be recorded and stored for analysis later.

We will also ask you to provide saliva samples prior to your lab visit, and your child to provide samples during the visit. We will measure the amount of the stress hormone, cortisol, and the changes in a specific gene from these samples. Saliva samples are collected by placing a small cotton swab in your mouth for two minutes. Detailed instructions regarding the saliva sampling process are enclosed in your information pack. We will use special infant swabs for collecting saliva from your child.

How can you get involved?

If you have been contacted and you are willing to participate in the research, we will send you an information leaflet and an appointment will be made for your family to visit the lab in Trinity College. When you visit, you will be required to sign a consent form, indicating that you have read the information leaflet, had all questions answered and are happy to participate in the study.

What will happen to the findings of the study?

All information collected from your family will be treated in the strictest of confidence and individuals will not be identified in any written reports. All questionnaire/assessment data will be anonymously coded (names and addresses will not be linked to that data), and links can only be made between questionnaire data, and the observation data by the researchers. Only the researchers working on the study will have access to the video material, which will be kept in a secure location. Video data will only be used for the purpose of research. In these cases, it is not possible to anonymise the data, as you can of course be seen and heard on the video recordings.

If you would be happy to allow us to use your stored video data for other research questions in future research projects under the same strict conditions of storage and confidentiality, we will ask you to sign a separate consent form also.

Under the Freedom of Information Act, you can have access to any information we store about you, if requested. The information we have collected from you and your family will be retained at least until the 3-year analysis has been completed, which is estimated to occur in Spring 2021. Following this, if you have consented to further contact from the TCD Infant and Child Laboratory, their researchers may contact you regarding your interest in attending a follow-up session. Your data may be securely retained for a maximum of 10 years from the project's completion date, at which point it will be disposed of.

In the event that you or any member of your family reveal information that causes concern or worry for the researchers, or in the event that the researcher observes an interaction that makes him/her concerned for the welfare/safety of the child/parent, the researcher is obliged to follow this up afterwards.

If, in the course of the study, the researcher has concerns about your current mental health, Professor Veronica O'Keane, Consultant Psychiatrist in Tallaght Hospital, will be contacted. If it is felt that it would be beneficial to you, Professor O'Keane will make a referral to your GP or your local HSE psychiatry service.

Appendix B. Participant Consent Form



Consent Form

There are five sections in this consent form. Each section contains statements and corresponding boxes, which we ask for you to tick, to indicate agreement with a given statement.

Please feel free to ask any questions while reading this form.
Thank you for participating in this study.

1. General Consent

I confirm that I have read the information leaflet for this study. The information has been fully explained to me and all questions have been answered to my satisfaction.

I understand that this study involves being observed and recorded as I interact with my child. I understand that the study will also involve cognitive and language assessments of my child.

I consent to being contacted by researchers as part of this research study.

I understand that this study is entirely voluntary and I am free to withdraw from participation at any time.

I understand that if anything emerges during the lab visit that causes the researcher to be concerned about me or my child, the researcher will have an obligation to follow this up afterwards. This procedure has been outlined in the information leaflet and explained to me by the researcher.

I understand that I will not be paid to take part in this study, but will receive €30 to cover childcare for siblings or travel expenses made on the day of my lab visit.

I have been informed of the risks, benefits and alternatives of this research, and consent for my child and myself to take part in this study.



2. Data Processing

I understand that my personal information will be protected in accordance with the General Data Protection Regulation, and give informed explicit consent to have my data processed as part of this research study.

I understand that all questionnaire and assessment information will be anonymously coded and used only for the purpose of the research.

I understand that it is not possible to anonymise my video data as my child and I will be seen in the video recordings, and that this data will be kept in a secure location, and used only for the purpose of this study.

I understand that under the Freedom of Information Act, I can have access to any of the information that is stored about me, if requested.

I understand that I am free to withdraw from participation at any time, and also understand that I will not be able to retrieve my data once it becomes part of an analysis or report.

I understand that information collected may be securely retained for a period of 10 years from the completion of the study, at which point it will be destroyed.



3. Biological Samples

I agree to provide saliva samples to undergo cortisol and epigenetic analysis, for use in this study, as outlined in the information leaflet.

I agree to allow the researcher to obtain saliva samples from my child, during our lab visit, for the same purpose.

I understand that I can request withdrawal of my saliva samples and for them to be destroyed. I also understand that I may decline to participate in saliva sampling at any time, yet still take part in the rest of the study.

I understand that my saliva samples will be stored in a secure freezer, using an anonymised study ID number until analysis, and that all samples will be kept confidential and for research purposes only.

I understand that all samples will be disposed of in a lawful, respectful way, once the analysis is complete.

4. Future Use of Video Material

The video data we have collected from you is a very valuable resource and it could be used to answer a lot of different research questions. We would be grateful if you would consider consenting to the inclusion of the data and video material collected from your family for other related research projects in the future.

Please note that as data like facial expression and tone of voice are so important in the sort of questions we are asking, you and your child would be identifiable in the videos, but only researchers would have access to these, and any identifying information will be removed from all other data.

Therefore, we are also seeking consent for the storage of your data for possible future research. Please choose one of the following options, as you see fit:

OPTION 1: *I give permission for material/data to be stored for possible future research related to the current study only if consent is obtained at the time of the future research and only if the research is approved by a Research Ethics Committee.* Yes No

OPTION 2: *I give permission for material/data to be stored for possible future research related to the current study without further consent being required but only if the research is approved by a Research Ethics Committee.* Yes No

OPTION 3: *I give permission for material/data to be stored for possible future research unrelated to the current study only if consent is obtained at the time of the future research and only if the research is approved by a Research Ethics Committee.* Yes No

OPTION 4: *I give permission for material/data to be stored for possible future research unrelated to the current study without further consent being required but only if the research is approved by a Research Ethics Committee.* Yes No



5. Consent to Contact Regarding Follow-up Visit

We would like to take this opportunity to thank you once more for your generosity in participating in this study.

This type of research assumes that the way we routinely interact with our infants and young children influences not only their behaviour and responses in the short term but critically influences many aspects of their later development.

The data we have collected from you today is very valuable and can help us to answer many questions about the dynamics of interaction. We are also very interested in how our behaviour now impacts children's development over time. We would love to be able to explore this further with your child at a later date.

If you would be willing to consider participating in a follow-up visit, please respond to the statements below.

I agree that the researchers may contact me to participate in a follow-up study within a 2 year period.

I understand that I am free to decline to participate in a follow-up study when contacted.

I consent to be re-contacted by researchers about possible future research **related** to the current study.

I consent to be re-contacted by researchers about possible future research **unrelated** to the current study, for which I may be eligible.

My signature below indicates that all of my questions have been answered. I agree to participate in the study as described above.

Participant (Parent)'s Name(s)

[Printed].....

Participant Signature Date

Participant (Child)'s Name(s)

[Printed].....

Witness Name (Printed)

Witness Signature Date

To be completed by the Principal Investigator or Nominee

I, the undersigned, have taken the time to fully explain to the above participant the nature and purpose of this study. I have explained the risks and possible benefits involved, and have invited them to ask questions on any aspect of the study that concerned them.

I have given a copy of the information leaflet and consent form to the participant, containing contact details for the study team.

Researcher Name

.....

Title and Qualifications

.....

Signature Date

Appendix C. Hamilton Depression Rating Scale

Hamilton Depression Rating Scale (HDRS)

Reference: Hamilton M. A rating scale for depression. *J Neurol Neurosurg Psychiatry* 1960; 23:56–62

Rating Clinician-rated

Administration time 20–30 minutes

Main purpose To assess severity of, and change in, depressive symptoms

Population Adults

Commentary

The HDRS (also known as the Ham-D) is the most widely used clinician-administered depression assessment scale. The original version contains 17 items (HDRS₁₇) pertaining to symptoms of depression experienced over the past week. Although the scale was designed for completion after an unstructured clinical interview, there are now semi-structured interview guides available. The HDRS was originally developed for hospital inpatients, thus the emphasis on melancholic and physical symptoms of depression. A later 21-item version (HDRS₂₁) included 4 items intended to subtype the depression, but which are sometimes, incorrectly, used to rate severity. A limitation of the HDRS is that atypical symptoms of depression (e.g., hypersomnia, hyperphagia) are not assessed (see SIGH-SAD, page 55).

Scoring

Method for scoring varies by version. For the HDRS₁₇, a score of 0–7 is generally accepted to be within the normal

range (or in clinical remission), while a score of 20 or higher (indicating at least moderate severity) is usually required for entry into a clinical trial.

Versions

The scale has been translated into a number of languages including French, German, Italian, Thai, and Turkish. As well, there is an Interactive Voice Response version (IVR), a Seasonal Affective Disorder version (SIGH-SAD, see page 55), and a Structured Interview Version (HDS-SIV). Numerous versions with varying lengths include the HDRS₁₇, HDRS₂₁, HDRS₂₉, HDRS₈, HDRS₆, HDRS₂₄, and HDRS₇ (see page 30).

Additional references

Hamilton M. Development of a rating scale for primary depressive illness. *Br J Soc Clin Psychol* 1967; 6(4):278–96.

Williams JB. A structured interview guide for the Hamilton Depression Rating Scale. *Arch Gen Psychiatry* 1988; 45(8):742–7.

Address for correspondence

The HDRS is in the public domain.

Hamilton Depression Rating Scale (HDRS)

PLEASE COMPLETE THE SCALE BASED ON A STRUCTURED INTERVIEW

Instructions: for each item select the one “cue” which best characterizes the patient. Be sure to record the answers in the appropriate spaces (positions 0 through 4).

1 DEPRESSED MOOD (*sadness, hopeless, helpless, worthless*)

- 0 Absent.
 1 These feeling states indicated only on questioning.
 2 These feeling states spontaneously reported verbally.
 3 Communicates feeling states non-verbally, i.e. through facial expression, posture, voice and tendency to weep.
 4 Patient reports virtually only these feeling states in his/her spontaneous verbal and non-verbal communication.

2 FEELINGS OF GUILT

- 0 Absent.
 1 Self reproach, feels he/she has let people down.
 2 Ideas of guilt or rumination over past errors or sinful deeds.
 3 Present illness is a punishment. Delusions of guilt.
 4 Hears accusatory or denunciatory voices and/or experiences threatening visual hallucinations.

3 SUICIDE

- 0 Absent.
 1 Feels life is not worth living.
 2 Wishes he/she were dead or any thoughts of possible death to self.
 3 Ideas or gestures of suicide.
 4 Attempts at suicide (any serious attempt rate 4).

4 INSOMNIA: EARLY IN THE NIGHT

- 0 No difficulty falling asleep.
 1 Complains of occasional difficulty falling asleep, i.e. more than ½ hour.
 2 Complains of nightly difficulty falling asleep.

5 INSOMNIA: MIDDLE OF THE NIGHT

- 0 No difficulty.
 1 Patient complains of being restless and disturbed during the night.
 2 Waking during the night – any getting out of bed rates 2 (except for purposes of voiding).

6 INSOMNIA: EARLY HOURS OF THE MORNING

- 0 No difficulty.
 1 Waking in early hours of the morning but goes back to sleep.
 2 Unable to fall asleep again if he/she gets out of bed.

7 WORK AND ACTIVITIES

- 0 No difficulty.
 1 Thoughts and feelings of incapacity, fatigue or weakness related to activities, work or hobbies.
 2 Loss of interest in activity, hobbies or work – either directly reported by the patient or indirect in listlessness, indecision and vacillation (feels he/she has to push self to work or activities).
 3 Decrease in actual time spent in activities or decrease in productivity. Rate 3 if the patient does not spend at least three hours a day in activities (job or hobbies) excluding routine chores.
 4 Stopped working because of present illness. Rate 4 if patient engages in no activities except routine chores, or if patient fails to perform routine chores unassisted.

8 RETARDATION (slowness of thought and speech, impaired ability to concentrate, decreased motor activity)

- 0 Normal speech and thought.
 1 Slight retardation during the interview.
 2 Obvious retardation during the interview.
 3 Interview difficult.
 4 Complete stupor.

9 AGITATION

- 0 None.
 1 Fidgetiness.
 2 Playing with hands, hair, etc.
 3 Moving about, can't sit still.
 4 Hand wringing, nail biting, hair-pulling, biting of lips.

10 ANXIETY PSYCHIC

- 0 No difficulty.
 1 Subjective tension and irritability.
 2 Worrying about minor matters.
 3 Apprehensive attitude apparent in face or speech.
 4 Fears expressed without questioning.

11 ANXIETY SOMATIC (physiological concomitants of anxiety) such as:

gastro-intestinal – dry mouth, wind, indigestion, diarrhea, cramps, belching
cardio-vascular – palpitations, headaches
respiratory – hyperventilation, sighing
urinary frequency
sweating

- 0 Absent.
 1 Mild.
 2 Moderate.
 3 Severe.
 4 Incapacitating.

12 SOMATIC SYMPTOMS GASTRO-INTESTINAL

- 0 None.
 1 Loss of appetite but eating without staff encouragement. Heavy feelings in abdomen.
 2 Difficulty eating without staff urging. Requests or requires laxatives or medication for bowels or medication for gastro-intestinal symptoms.

13 GENERAL SOMATIC SYMPTOMS

- 0 None.
 1 Heaviness in limbs, back or head. Backaches, headaches, muscle aches. Loss of energy and fatigability.
 2 Any clear-cut symptom rates 2.

14 GENITAL SYMPTOMS (symptoms such as loss of libido, menstrual disturbances)

- 0 Absent.
 1 Mild.
 2 Severe.

15 HYPOCHONDRIASIS

- 0 Not present.
 1 Self-absorption (bodily).
 2 Preoccupation with health.
 3 Frequent complaints, requests for help, etc.
 4 Hypochondriacal delusions.

16 LOSS OF WEIGHT (RATE EITHER a OR b)

- | a) According to the patient: | b) According to weekly measurements: |
|--|---|
| 0 <input type="checkbox"/> No weight loss. | 0 <input type="checkbox"/> Less than 1 lb weight loss in week. |
| 1 <input type="checkbox"/> Probable weight loss associated with present illness. | 1 <input type="checkbox"/> Greater than 1 lb weight loss in week. |
| 2 <input type="checkbox"/> Definite (according to patient) weight loss. | 2 <input type="checkbox"/> Greater than 2 lb weight loss in week. |
| 3 <input type="checkbox"/> Not assessed. | 3 <input type="checkbox"/> Not assessed. |

17 INSIGHT

- 0 Acknowledges being depressed and ill.
 1 Acknowledges illness but attributes cause to bad food, climate, overwork, virus, need for rest, etc.
 2 Denies being ill at all.

Total score:

Appendix D. Center for Epidemiologic Studies - Depression Scale (CES-D)

During the Past Week				
	Rarely or none of the time (less than 1 day)	Some or a little of the time (1-2 days)	Occasionally or a moderate amount of time (3-4 days)	Most or all of the time (5-7 days)
1. I was bothered by things that usually don't bother me.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. I did not feel like eating; my appetite was poor.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. I felt that I could not shake off the blues even with help from my family or friends.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. I felt I was just as good as other people.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. I had trouble keeping my mind on what I was doing.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. I felt depressed.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. I felt that everything I did was an effort.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. I felt hopeful about the future.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. I thought my life had been a failure.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. I felt fearful.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. My sleep was restless.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. I was happy.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13. I talked less than usual.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14. I felt lonely.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15. People were unfriendly.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16. I enjoyed life.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17. I had crying spells.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18. I felt sad.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19. I felt that people dislike me.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20. I could not get "going."	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

SCORING: zero for answers in the first column, 1 for answers in the second column, 2 for answers in the third column, 3 for answers in the fourth column. The scoring of positive items is reversed. Possible range of scores is zero to 60, with the higher scores indicating the presence of more symptomatology.

Appendix E. Perceived Stress Scale (PSS)

Name: _____

Age: _____

The questions in this scale ask you about your feelings and thoughts during the last month. In each case, you will be asked to indicate *how often* you felt or thought a certain way. Although some of the questions are similar, there are differences between them and you should treat each one as a separate question. The best approach is to answer each question fairly quickly. That is, don't try to count up the number of times you felt a particular way, but rather indicate the alternative that seems like a reasonable estimate.

In the last month...	0 Never	1 Almost Never	2 Sometimes	3 Fairly Often	4 Very Often
1. How often have you been upset because of something that happened unexpectedly?					
2. How often have you felt that you were unable to control the important things in your life?					
3. How often have you felt nervous and "stressed"?					
4. How often have you dealt successfully with irritating life hassles?					
5. How often have you felt that you were effectively coping with important changes that were occurring in your life?					
6. How often have you felt confident about your ability to handle your personal problems?					
7. How often have you felt that things were going your way?					
8. How often have you found that you could not cope with all the things that you had to do?					
9. How often have you been able to control irritations in your life?					
10. How often have you felt that you were on top of things?					
11. How often have you been angered because of things that happened that were outside of your control?					
12. How often have you found yourself thinking about things that you have to accomplish?					
13. How often have you been able to control the way you spend your time?					
14. How often have you felt difficulties were piling up so high that you could not overcome them?					

Appendix F. Pittsburgh Sleep Quality Index (PSQI)

Name: _____

Age: _____

The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions.

During the past month,

1. When have you usually gone to bed? _____
2. How long (in minutes) has it taken you to fall asleep each night? _____
3. When have you usually gotten up in the morning? _____
4. How many hours of actual sleep do you get at night? (This may be different to the number of hours you spend in bed). _____

5. During the past month, how often have you had trouble sleeping because you...	Not during the past month (0)	Less than once a week (1)	Once or twice a week (2)	Three or more times a week (3)
a. Cannot get to sleep within 30 minutes				
b. Wake up in the middle of the night or early morning				
c. Have to get up to use the bathroom				
d. Cannot breathe comfortably				
e. Cough or snore loudly				
f. Feel too cold				
g. Feel too hot				
h. Have bad dreams				
i. Have pain				
j. Other reason(s), please describe, including how often you have had trouble sleeping for this reason:				
6. During the past month, how often have you take medicine (prescribed or over the counter) to help you sleep?				
7. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?				
8. During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done?				
	Very good (0)	Fairly good (1)	Fairly bad (2)	Very bad (3)
9. During the past month, how would you rate your sleep quality overall?				

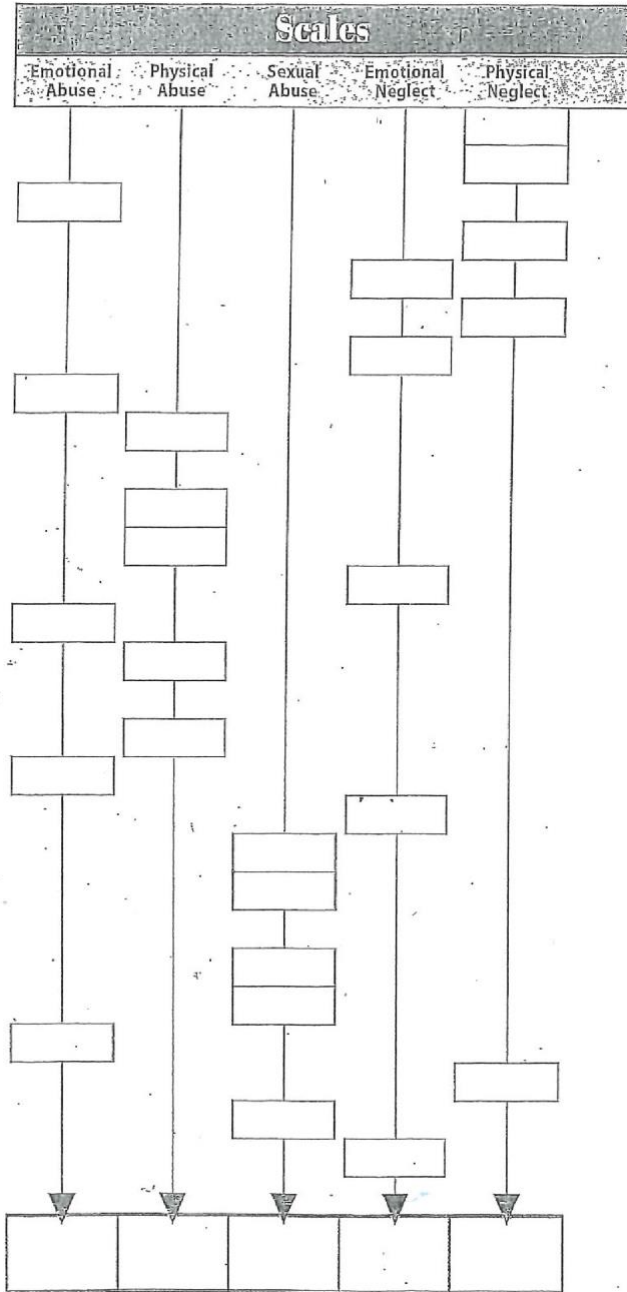
Appendix G. Childhood Trauma Questionnaire – Short Form (CTQ- SF)

When I was growing up...	Never true	Rarely true	Sometimes true	Often true	Very often true
1. I didn't have enough to eat.					
2. I knew that there was someone to take care of me and protect me.					
3. People in my family called me things like "stupid," "lazy," or "ugly."					
4. My parents were too drunk or high to take care of the family.					
5. There was someone in my family who helped me feel that I was important or special.					
6. I had to wear dirty clothes.					
7. I felt loved.					
8. I thought that my parents wished I had never been born.					
9. I got hit so hard by someone in my family that I had to see a doctor or go to the hospital.					
10. There was nothing I wanted to change about my family.					
11. People in my family hit me so hard that it left me with bruises or marks.					
12. I was punished with a belt, a board, a cord, or some other hard object.					
13. People in my family looked out for each other.					
14. People in my family said hurtful or insulting things to me.					
15. I believe that I was physically abused.					
16. I had the perfect childhood.					
17. I got hit or beaten so badly that it was noticed by someone like a teacher, neighbor, or doctor.					
18. I felt that someone in my family hated me.					
19. People in my family felt close to each other.					
20. Someone tried to touch me in a sexual way, or tried to make me touch them.					
21. Someone threatened to hurt me or tell lies about me unless I did something sexual with them.					
22. I had the best family in the world.					
23. Someone tried to make me do sexual things or watch sexual things.					
24. Someone molested me.					
25. I believe that I was emotionally abused.					
26. There was someone to take me to the doctor if I needed it.					
27. I believe that I was sexually abused.					
28. My family was a source of strength and support.					



Name: _____
Age: _____ Sex: _____

Ready Score®
Answer Document



Emotional abuse scale total score (5-25) Physical abuse scale total score (5-25) Sexual abuse scale total score (5-25) Emotional neglect scale total score (5-25) Physical neglect scale total score (5-25)

Item Response Scores						Item score on item score scale (0-5)
Never True	Rarely True	Sometimes True	Often True	Very Often True		
1.	1	2	3	4	5	
2.	5	4	3	2	1	
3.	1	2	3	4	5	
4.	1	2	3	4	5	
5.	5	4	3	2	1	
6.	1	2	3	4	5	
7.	5	4	3	2	1	
8.	1	2	3	4	5	
9.	1	2	3	4	5	
10.	1	2	3	4	5	0
11.	1	2	3	4	5	
12.	1	2	3	4	5	
13.	5	4	3	2	1	
14.	1	2	3	4	5	
15.	1	2	3	4	5	
16.	1	2	3	4	5	0
17.	1	2	3	4	5	
18.	1	2	3	4	5	
19.	5	4	3	2	1	
20.	1	2	3	4	5	
21.	1	2	3	4	5	
22.	1	2	3	4	5	0
23.	1	2	3	4	5	
24.	1	2	3	4	5	
25.	1	2	3	4	5	
26.	5	4	3	2	1	
27.	1	2	3	4	5	
28.	5	4	3	2	1	

Minimisation/denial scale total score (0-3)

Appendix H. Saliva swab instructions

Participant Step-by-Step Instructions Saliva Sample Collection

- The purpose of the saliva collection is to measure changes in stress hormones throughout the morning.
- The saliva will be collected by placing the swab provided under your tongue for 1-2 minutes after which you will place the swab in the tube provided. Please see detailed instructions below.
- The tubes will be labelled with time points corresponding to each collection after waking.
- You will have **3 collections** in total. You should put them in the plastic bag provided and place the samples in the refrigerator.
- Please bring the saliva tubes with you to the Infant and Child Research Laboratory.

The tubes will be labelled for the specific times below. Please collect saliva at each of these consecutive times after waking for **one** day.

1. 0 minutes (on waking)
2. 30 minutes (after waking)
3. 60 minutes (after waking)

For example, if you wake up at 7.00 am, you will be collecting samples at:

1. 7.00 am (approximately)
2. 7.30 am
3. 8.00 am

How to take samples:

Take the tube marked with the appropriate time point, remove the blue cap on the tube and then remove the swab in the smaller tube. Place the swab under your tongue for 1-2 minutes. Then return the saturated swab into the smaller tube and close it firmly with the blue top. Please ensure that the saturated swab is placed in the smaller tube that clicks into the larger tube. Place all samples in the refrigerator until your appointment at the Infant and Child Research Lab.

Please do not brush your teeth prior to collecting the morning samples. Please rinse your mouth out with water 5 min before taking a sample (Please make sure that you only collect saliva and not water from rinsing your mouth out!)

If you have any questions, please contact Laura Nix (nixl@tcd.ie).

Appendix I. Locks board used for 2-year laboratory stressor

Appendix J. PICCOLO Affection Rating Scale

ID # _____ Name: _____ Child's birth date: ____/____/____ Today's date: ____/____/____



Parenting Interactions with Children

Checklist of Observations Linked to Outcomes

INSTRUCTIONS: Look closely to see behaviours in a quiet parent. Frequency is more important than complexity, but complexity often includes several examples.

Item	Parent...	Observation guidelines	Absent (0)	Barely (1)	Clearly (2)
1	Speaks in a warm tone of voice	Parent's voice is positive in tone and may show enthusiasm or tenderness. A parent who speaks little but very warmly should be coded highly.			
2	Smiles at child	Parent directs smiles toward child, but parent and child do not need to be looking at each other when smile occurs. Includes small smiles.			
3	Praises child	Parent says something positive about child characteristics or about what child is doing. A "thank you" can be coded as praise.			
4	Is physically close to child	Parent is within easy arm's reach of child, comfortably able to soothe or help. Consider context: Expect more closeness for book reading than for playing house.			
5	Uses positive expressions with child	Parent says positive things or uses words like "honey", "kiddo" or an affectionate nickname. (Note: emphasis on verbal expressions.)			
6	Is engaged in interacting with child	Parent is actively involved together <i>with</i> child, not just with activities or with another adult.			
7	Shows emotional warmth	Parent shows enjoyment, fondness or other positive emotion about child and directed to child. (Note: includes verbal but emphasis on nonverbal).			
Affection total:					

- SCORING:**
- 0 "Absent" – no behaviour observed
 - 1 "Barely" – brief, minor, or emerging behaviour
 - 2 "Clearly" = definite, strong, or frequent behaviour

Appendix K. Coparenting rating scale

Coparenting Coding Scheme

Coparenting Coding Manual: New Parents Project (version April 2017)

Adapted from Cowan & Cowan (1996) and Bayer (1992).

UC = Uncodable

May be due to faces not visible or voices muffled/mumbled (use sparingly)

Co-Parenting Scales

Cooperation: Reflects the degree to which parents help and support one another in teaching and playing with the child. Help and support between parents can be instrumental as well as emotional. For instance, for the pop-up toy, higher scores are warranted if one parent pushes the toy down in a helpful way. That would be an example of instrumental support.

(5) Very High Cooperation: Parents are very frequently cooperative. Cooperation seems effortless. They do not interrupt one another or distract from the other's interventions with the child.

(4) High Cooperation: Each parent builds on the other's efforts to help the child. There are a few instances of minimal interruption or distraction from the other parent's interactions. Cooperation is easy/smooth and frequent.

(3) Moderate Cooperation: Parents generally work well with and support each other, though there are times when helping one another lapses and parents appear less in concert.

(2) Low Cooperation: Parents are usually not supportive or working together; they appear to have separate ways of working with their child. Occasionally, they'll share the same approach.

(1) Very Low Cooperation: No effort is made by parents to support and assist each other. Parents appear to be working with the child independently.

Competition: Parents try to outdo each other's efforts to teach, work, and play with the child. Lower-level competition includes parents using different approaches with the child but this type of competition seems accidental. At lower and moderate levels, couples lack coordination. But, in couples that receive higher ratings, parents appear to be intentionally competing for the child's attention.

(5) Very High Competition: Efforts to outdo one another's teaching/playing take precedence over helping the child learn. Competition is consistent and obvious throughout all parts of the interaction. Parents' main concern is clearly to outdo each other.

(4) High Competition: Parents may be playing with the child, but frequently try to outdo each other to get the attention of the child. There are multiple instances of competition, but it is not seen in all parts of the interaction.

(3) Moderate Competition: There are multiple low-level instances of competition or 1 very strong instance seen.

(2) Low Competition: Occasionally, a comment or behavior will be made by one parent suggesting that they feel they have a more effective parenting strategy, though it comes across as constructive (or accidental) and not challenging. May be 1 instance of trying to mildly out-do each other.

(1) Very Low Competition: No competition visible.

Individual Scales

Warmth: One parent demonstrates affection and positive regard for the other; laughing, touching, smiling, saying nice things to each other. Parent attempts to involve the other in the interaction – a connection is felt and can be seen between them. Parent provides emotional support, reassurance, and encouragement for the other in an authentic, not sarcastic, manner.

(5) Very High Warmth: Continual expressions of warmth (i.e. smiling, laughing, touching, gazing into each other's eyes) fill the episode. If coders see any expressions of physical affection (hugs, kisses, holding hands), a "5" should be seriously considered.

(4) High Warmth: One parent clearly demonstrates affection for the other. This warmth may be visible or just a general feeling of connectedness between them. The warmth, however, is not as pervasive as would be seen in a level (5).

(3) Moderate Warmth: Parent displays a reasonable amount of affection for the other. The sense of connectedness is apparent but not striking. The parent interacts lovingly, at times, with the other (smiles, positive comments, etc.), but this behavior or the connection behind it is not apparent throughout the episode.

(2) Low Warmth: Parent is less open and relatively tentative in their display of affection for their partner. There is a very limited sense of connectedness between them.

(1) Very Low Warmth: No warmth visible or felt from partners; seem disconnected from each other.

Coldness: Parent seems distant, closed-off, and lacks affection for the other. There is a sense of the parent keeping a distance between his/her partner. This is visible through curtness (shortness), snubbing (ignoring), hostile responses, or a general lack of response towards the other parent's attempts to engage in interaction.

(5) Very High Coldness: Non-engagement with partner predominates and appears to be intentional. Parent seems disinterested in partner and *disdain* is visible. One parent has no reaction to the other AT ALL. **(Some snubbing must be seen).**

(4) High Coldness: Parent interacts with partner, but in a clearly withdrawn or distant fashion. Parent rejects partner's attempts for closeness (this may be *emotional or physical*). Frequent snubbing is seen. **(Some snubbing must be seen).**

(3) Moderate Coldness: Parent lacks interaction with partner throughout entire episode OR some mild snubbing (verbal or nonverbal) of partner's attempts get close to the other partner (physically or emotionally). There are multiple low level snubbing instances or 1 strong instance shown.

(2) Low Coldness: Some withdrawal is visible. Parent is generally open to his/her partner and to their attempts for warmth without necessarily initiating this contact themselves. There may be 1 instance of low level snubbing OR a slight distance between partners. They do not interact much but are not necessarily hostile.

(1) Very Low Coldness: No coldness visible between parents.

Pleasure: The parent appears to enjoy sharing and collaborating in the parental role and is able to demonstrate that during the interaction. The partner appears to take pleasure in the OTHER PARENT'S relationship with the child. They are able to watch comfortably when the other is interacting individually with the baby. The parent displays playfulness and humor with the other about their respective parenting styles/practices and their relationship with the child.

(5) Very High Pleasure: Such expressions of pleasure and appreciation are very frequent and of high intensity throughout the entire episode. Parent is very attentive and thoroughly enjoys watching partner play with the child. The parent may smile lovingly while the other is playing, showing no negative emotion or disinterest whatsoever.

(4) High Pleasure: Parent expresses/shows their enjoyment and appreciation of how their partner plays with the child and of the relationship between their partner and the child. They can comfortably share involvement with their partner or enjoy watching the dyad together. Intensity of pleasure, however, is not as high as in a level (5).

(3) Moderate Pleasure: Parent seems to enjoy partner's relationship with child and parenting with their partner. However, enjoyment is not present at all times and is generally muted in some way. The parent's enjoyment of the other is partly inferred rather than directly observed.

(2) Low Pleasure: Though parent does not necessarily show negative feelings toward the other, they show enjoyment of the other parent's relationship with the child only on occasion.

(1) No Pleasure: No pleasure is visible between parents. Their response to partner's relationship is either neutral or negative in tone.

Displeasure: The parent expresses dislike of their partner's style of interacting with the child either directly or indirectly (sarcasm). This can be a reaction to the positivity or negativity in their relationship. Parents do not enjoy working together.

(5) Very High Displeasure: Parent is displeased OR threatened by other parent's relationship with the child. Displeasure characterizes the episode. This may be expressed through *comments or gestures throughout the episode* ("He likes playing with you more than me" "Don't hold her like that!" or rolling of the eyes) (at least 2 comments and low level expressions/behaviors).

(4) High Displeasure: One parent actively shows or says they dislike how the other is parenting, or criticizes the other's relationship with the child. Statements are overt and feelings are clearly shown, though not as often as in a level (5) (Multiple comments).

(3) Moderate Displeasure: Predominately sarcastic or subtle comments or tone during interaction suggest a parent's dislike of the other's relationship with the child, OR on only one occasion a partner shows one clear comment indicating displeasure OR multiple low level displeasure indications.

(2) Low Displeasure: Parent is generally unbothered by their partner's relationship with the child; however, they might occasionally jab or otherwise indicate some negative feelings. *Non-verbal* indications of displeasure: laughter, sounds, or faces. If situations are difficult to decipher but appear to possibly be negative in some way score a 2.

(1) Very Low Displeasure: No displeasure is visible.

Appendix L. Supplementary Language Tables

Descriptive data for the language used by parents during triadic play interactions at 2 years.

Play context	Parent	Language variable	Control		History		Depressed	
			Mdn	IQR	Mdn	IQR	Mdn	IQR
Triadic structured	Mother	Total utterances	93.0	28.0	73.0	37.0	64.0	35.0
		MLU in morphemes	3.96	0.85	3.74	1.64	4.77	1.35
		MLU in words	3.81	0.80	3.76	1.46	4.37	1.32
		VOCD	32.51	12.22	39.47	13.08	35.81	12.15
	Father	Total utterances	53.50	49.75	75.0	22.0	51.0	35.25
		MLU in morphemes	4.45	0.71	3.48	1.43	4.00	0.99
		MLU in words	4.16	0.85	3.38	1.39	3.86	0.95
		VOCD	33.55	13.08	37.91	16.0	31.88	18.0
Triadic free play	Mother	Total utterances	157.50	60.0	127.22	54.0	129.5	75.5
		MLU in morphemes	4.2	0.68	3.45	1.72	4.43	0.78
		MLU in words	3.99	0.62	3.25	1.49	4.15	0.67
		VOCD	43.42	15.61	44.81	13.97	51.48	8.89
	Father	Total utterances	76.0	45.25	107.0	39.0	100.50	69.25
		MLU in morphemes	3.97	0.90	3.65	1.04	3.72	0.99
		MLU in words	3.83	0.87	3.31	0.96	3.48	0.82
		VOCD	41.52	8.43	44.08	20.83	49.48	28.01

Note. MLU = Mean Length in Utterance; VOCD = Vocabulary Diversity.

Descriptive data for the language used by parents during dyadic and triadic free play interactions at 3 years.

Play context	Parent	Language variable	Control		History		Depressed	
			Mdn	IQR	Mdn	IQR	Mdn	IQR
Dyadic free play	Mother	Total utterances	188	79.50	194	74	185.5	52.25
		MLU morphemes	4.35	0.36	4.59	1.02	4.42	0.57
		MLU words	4.14	0.35	4.28	1.03	4.14	0.37
		VOCD	50.06	6.40	51.99	9.66	58.17	14.42
	Father	Total utterances	147	69.50	201	21.38	-	-
		MLU morphemes	4.24	0.45	3.48	0.96	-	-
		MLU words	4.09	0.36	3.30	0.59	-	-
		VOCD	38.65	11.74	53.25	7.86	-	-
Triadic free play	Mother	Total utterances	117.50	24.25	195	69.97	-	-
		MLU morphemes	4.96	1.69	3.93	0.89	-	-
		MLU words	4.62	1.60	3.74	1.01	-	-
		VOCD	53.97	17	49.52	11.75	-	-
	Father	Total utterances	66	130	86	34.52	-	-
		MLU morphemes	5.28	1.19	4.31	0.72	-	-
		MLU words	5.01	0.99	4.02	0.81	-	-
		VOCD	43.85	9.66	43.03	20.63	-	-

Note. MLU = Mean Length of Utterance; VOCD = Vocabulary Diversity.

Descriptive data for the language used by children during dyadic and triadic play interactions at 2 years.

Play context	Language variable	Control		History		Depressed	
		Mdn	IQR	Mdn	IQR	Mdn	IQR
Mother-child dyadic structured play	Total utterances	33.0	39.0	38.0	34.0	25.5	48.0
	MLU morphemes	1.88	1.05	1.93	0.88	1.53	0.83
	Total word types	32.0	26.25	29.0	27.0	24.5	39.75
Mother-child dyadic free play	Total utterances	85.0	66.75	76.0	33.0	65.0	76.5
	MLU morphemes	2.16	0.67	2.01	0.68	2.04	0.67
	Total word types	67.5	38.0	60.0	52.0	44.0	48.25
Father-child dyadic structured play	Total utterances	43.5	26.25	24.5	34.25	39.6	32.5
	MLU morphemes	1.65	0.92	1.94	0.70	1.87	0.83
	Total word types	31.0	20.75	24.0	19.75	27.0	18.5
Father-child dyadic free play	Total utterances	79.0	32.75	55.0	63.5	66	42.5
	MLU morphemes	1.75	0.60	1.60	0.85	1.73	0.75
	Total word types	52.0	23.25	36.5	57.5	43.0	34.5
Triadic structured play	Total utterances	31.5	18.75	18.0	30.0	20.0	22.0
	MLU morphemes	1.99	0.91	1.77	0.85	2.00	0.95
	Total word types	29.0	16.25	21.0	45.0	23.0	38.5
Triadic free play	Total utterances	68.0	49.25	45.0	44.5	57.0	31.5
	MLU morphemes	1.86	0.86	1.56	0.64	1.66	0.73
	Total word types	48.0	25.0	29.0	46.0	45.5	13.5

Descriptive data for the language used by children during dyadic and triadic free play interactions at 3 years.

Play context	Language variable	Control		History		Depressed	
		Mdn	IQR	Mdn	IQR	Mdn	IQR
Mother-child dyadic free play	Total utterances	132.0	80.5	93.0	42.5	128.0	56.75
	MLU morphemes	3.0	0.46	2.82	0.76	3.02	0.54
	Total word types	110.0	46.5	94.0	25.25	107.5	19.5
Father-child dyadic free play	Total utterances	86.0	26.41	120.0	24.04	-	-
	MLU morphemes	3.01	0.77	2.18	0.57	-	-
	Total word types	102.0	24.85	97.5	21.51	-	-
Triadic free play	Total utterances	92.0	40.75	110.0	39.72	-	-
	MLU morphemes	3.55	1.13	1.98	0.63	-	-
	Total word types	99.5	48.5	73.0	22.52	-	-