Maternal Depressive Symptoms and Child Behavior Problems

Moderation by Child Characteristics

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Submitted as Cand. Psychol. Thesis

Department of Psychology

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Abstract

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Background: Maternal depression is common, and a known risk for negative child development, including behavior problems. However, many children of depressed mothers do not develop behavior problems, and identifying children at greater risk could increase understanding of the mechanisms involved and improve health interventions. **Objectives:** The present study aims to investigate three theoretically proposed child characteristics (gender, temperament and inhibitory control) as potential moderators of the empirically established association between maternal depressive symptoms and child behavior problems (internalizing and externalizing problems). **Methods:** The present study utilizes data from PhD Tone Kristine Hermansen's doctoral project, which is based on participants from The Norwegian Mother and Child Cohort Study (MoBa). A sample of 96 mothers and their children (mean age 5.7 years, 49 girls) were assessed using self-report measures of concurrent maternal depressive symptoms (BDI-II), child temperament (EAS) and child internalizing and externalizing problems (CBCL). The children also completed a Flanker task as a measure of inhibitory control. The data was analyzed by conducting a series of hierarchical multiple regression analyses. **Results:** In line with prediction, higher levels of concurrent maternal depressive symptoms were found to predict higher levels of both child internalizing and externalizing problems. Child inhibitory control was found to moderate these associations so that lower levels of inhibitory control predicted a stronger association between concurrent maternal depressive symptoms and both child internalizing and externalizing problems. No moderation effects were found for child gender or temperament. **Conclusion:** The findings support the notion that maternal depression poses a risk for negative child development. Further, children with poorer inhibitory control seem to be more vulnerable to the negative effects of maternal depression.

Acknowledgements

First, I would like to thank the participating mothers and children for allowing us to expand the knowledge on the effects of maternal depression by giving of your time and effort. This study was conducted using data from PhD Tone Kristine Hermansen's doctoral project at the Cognitive Developmental Research Unit (EKUP), where professor Annika Melinder is the project manager. The participants were recruited from the larger research project The Norwegian Mother and Child Cohort Study (MoBa) conducted at the Norwegian Institute of Public Health, Division of Mental Health.

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Kari Enger Syrstad

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1 Introduction

Depressive disorders are common, and the World Health Organization (WHO) lists depression as being the single factor causing the most years lost to disability worldwide (Brummelte & Galea, 2010). The global point-prevalence of major depressive disorder has been estimated to be 4.7% (Ferrari et al., 2013), and the life-time prevalence in the U.S. has been found to be 19.2% (Kessler & Bromet, 2013). In Norway, different studies have reported life-time prevalence of severe depression between 8.3% and 17.8 % (Nasjonalt folkehelseinstitutt, 2014). Depression is not evenly distributed across genders, and women have been found to be approximately two times more likely to suffer from major depressive disorder compared to men (Kessler, 2003).

The International Classification of Diseases (ICD-10) describes depression as distinct episodes in time, lasting for at least two weeks, typically characterized by depressed mood, loss of interest and reduced energy (World Health Organization, 1992). The episodes can be classified as mild, moderate or severe, and the clinical presentation can vary substantially across individuals (World Health Organization, 1992). It is common that the onset of an individual episode can be related to a stressful life event (World Health Organization, 1992). The WHO classification of severe depression and the American Psychological Association classification of major depressive disorder have been found to be very similar (Hiller et al., 1994). Depressive episodes are often recurrent, with more than 80% of people with depression experiencing more than one episode (Goodman, 2007). When episodes of elevated mood are also present, depressive episodes can be part of a bipolar spectrum disorder (World Health Organization, 1992). Persistent mood disorders such as dysthymia or cyclothymia, are also characterized by depressive symptoms, but individual episodes are not sufficiently severe or long lasting to be classified as depressive episodes (World Health Organization, 1992). The rates of comorbidity between depression and other mental disorders are high, with about half of patients with major depressive disorder having at least one comorbid diagnosis, most frequently anxiety, substance abuse or eating disorders (Carter, Garrity-Rokous, Chazan-Cohen, Little, & Briggs-Gowan, 2001).

The sex difference found in life-time prevalence of depression has partly been attributed to periods of sex hormone excess or -deprivation during women's fertile years (Poromaa, Comasco, Georgakis, & Skalkidou, 2017), difference in susceptibility to hormonal changes

(Noble, 2005) and difference in stress sensitivity between the sexes (Brummelte & Galea, 2010). In addition to hormonal changes that comes with pregnancy and child birth, the childrearing years brings potentially stressful life-events for both sexes, including parenting in general (Poromaa et al., 2017). Major depressive disorder has been found to be more prevalent in mothers compared to other women (Ertel, Rich-Edwards, & Koenen, 2011). Depression is a disorder significantly affecting our social and emotional functioning (Luoma et al., 2001), making it more difficult to be a sensitive and available parent. Negative parenting behaviors and difficulty providing age-appropriate care is associated with parental depression (Goodman & Garber, 2017). The caregiver's sensitivity and responsivity to the child's needs are important for the development of a secure attachment, which in turn contributes to the child's development of emotion regulation (Carr, 2006).

An association between maternal mental illness and child behavior problems is consistently found across varieties of research designs and samples studied (O'Connor, Monk, & Burke, 2016). Child behavior problems are commonly categorized into the two broad dimensions of internalizing and externalizing problems (Gjerde et al., 2017). The two terms have been used since the mid-sixties to describe distinct categories of emotional, behavioral and social problems (Achenbach, Ivanova, Rescorla, Turner, & Althoff, 2016). Internalizing problems broadly refers to problems affecting psychological wellbeing, including withdrawn, depressed, anxious and inhibited behaviors (Liu, 2004). Externalizing problems broadly refers to outward directed negative behavior, consisting of disruptive, hyperactive and aggressive behaviors (Liu, 2004). Potential mechanisms for the transfer of risk from mother to child include both biological and environmental pathways, interacting with one another and changing throughout the child's development (Goodman & Gotlib, 1999). The associations between maternal depression and negative child outcomes are thought to be transactional, where the child's characteristics or behavior may also enhance or reduce maternal depressive symptoms (Goodman & Gotlib, 1999; Sameroff, 1975).

In literature, parental depression is categorized into prenatal, postnatal and concurrent depression, which is during pregnancy, after delivery and at the time of measuring child outcome, respectively (Gjerde et al., 2017). The postnatal period is defined by WHO as the six weeks following childbirth (Matthews, Severin, & Jelka, 2010), but in research postnatal depression is often operationalized as occurring during the six months or even a year after delivery (Norhayati, Nik Hazlina, Asrenee, & Wan Emilin, 2014). The perinatal period is

including both the pre- and postnatal periods (Matthews et al., 2010). Perinatal and later concurrent depression in fathers has also been found to be associated with both internalizing and externalizing problems throughout child development (Sweeney & MacBeth, 2016). Still, the higher female prevalence, in addition to the mother's traditional role in potentially sensitive periods of early childhood, make mothers' depressive symptoms particularly relevant (Goodman & Gotlib, 1999). Also, Connell and Goodman (2002) found in their meta-analysis of 134 studies that both internalizing and externalizing problems in children are more strongly associated with maternal compared to paternal depression.

Based on the findings in their meta-analysis, Goodman et al. (2011) request research designs to move beyond just main effects models of maternal depression. As stated above, the association between maternal depression and negative child outcome has been well documented (Goodman et al., 2011). However, this effect is not universal, and some children seem more resilient, making it relevant to investigate potential moderators of this association (Jessee, Mangelsdorf, Shigeto, & Wong, 2012; Kushner, 2015; van Santvoort et al., 2015). The present paper aims to investigate how some theoretically proposed child characteristics may moderate the relationship between maternal depression and child internalizing and externalizing problems. The theoretical framework and relevant previous empirical findings will be described before presenting the hypotheses.

1.1 Theoretical Framework

Goodman and Gotlib (1999) have developed an integrative model of the transfer of risk from depressed mothers to their child, shown in Figure 1.1. Their perspective is developmental, and the importance of transactional relationships with mutual influence between the child and the environment is highlighted. The model has been developed to help identify moderators and mediators affecting the relationship between the mother's depression and negative child outcomes (Goodman & Gotlib, 1999). A moderator is a third variable which affects the strength and/or direction of the relationship between an independent variable (i.e. maternal depression) and the dependent variable (i.e. negative child outcome), informing us on *when* the associations occur or when they are stronger (Baron & Kenny, 1986). A mediator, on the other hand, is a variable through which the independent variable affects the dependent variable, informing us about *how* or *why* the association exists (Baron & Kenny, 1986). The model by Goodman and Gotlib (1999) is informed by the diathesis-stress or dual-risk model,

positing that psychopathology results from an interaction between stressors and biological vulnerability. According to this model, maternal depression leads to vulnerabilities through the proposed mediators, which in turn may lead to negative outcomes for the child in terms of depression or other psychopathology (Goodman & Gotlib, 1999). Furthermore, three moderators of the relationship between risk and outcome are also identified, where different levels of these variables are thought to be protective or leave the child more vulnerable to the effects of maternal depression (Goodman & Gotlib, 1999).

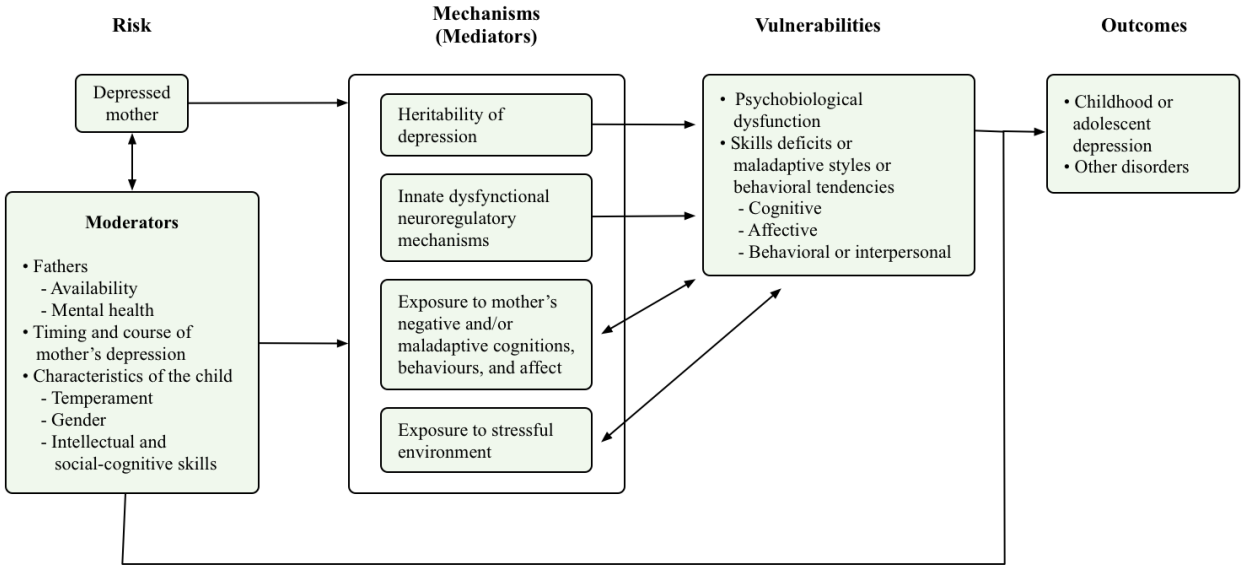

Figure 1.1 *An Integrative model for the transmission of risk to the children of depressed mothers by Goodman and Gotlib (1999).*

1.1.1 Mediators

The mediators between maternal depression and child outcomes in this model are referred to as mechanisms (Goodman & Gotlib, 1999). The model's first mediator is genetic transfer of vulnerability to depression (Goodman & Gotlib, 1999). It is well documented through twin- and adoption studies that adult-onset depression is largely heritable, with the heritability of major depression estimated to be between 31% and 42% (Sullivan, Neale, & Kendler, 2000). When it comes to child-onset depression, the evidence is more scarce, however, and the vulnerability inherited may be nonspecific in terms of outcome (Goodman et al., 2011). The relative importance of genetic influence changes across development, and the Twins Early Development Study (N=13,292) found that genetic influence on depressive symptoms

increased from childhood to adolescence as shared environmental effects decrease (Hannigan, McAdams, & Eley, 2017).

The second mediator concerns influence on the development of the fetus, and potentially dysfunctional neurological regulatory mechanisms the child is born with (Goodman & Gotlib, 1999). Altered programming of the child's hypothalamic-pituitary-adrenal (HPA) axis and possibly changes in the child's immune system are mechanisms by which the vulnerability may be transferred, although the evidence it still limited (O'Connor et al., 2016). The HPA-axis regulates levels of cortisol, which is a hormone released in response to stress (Seth, Lewis, & Galbally, 2016). Dysfunctional HPA activity is often found in depressed adults, and may be a predisposition for developing depression (Khoury et al., 2016). Measures of increased cortisol levels at birth amongst infants of depressed mothers are indicative of altered HPA-axis function (O'Connor et al., 2016). Furthermore, prenatal depression is associated with higher levels of norepinephrine and lower levels of dopamine in both the mother and the newborn baby, with the mother's levels predicting the newborn's (Lundy et al., 1999). Higher cortisol levels may also be a mediator for prenatal depression effects on fetal growth rate and gestational age, and has been found to be significantly associated with the variance of these variables (Field, 2011). The regulatory systems continue to develop throughout childhood, and postnatal maternal depressive symptoms may have an additional effect on child physiological regulation through sub-optimal mother-infant interactions (Khoury et al., 2016).

The third mechanism in the model captures five interconnected components. The first component is the direct exposure to the mother's depressed cognitions, behavior and emotion. Secondly, these are hypothesized to make the mother inadequate in meeting the child's social and emotional needs. Third, these unmet needs may limit the child's development of social and cognitive skills. Fourth, the child may through social learning adapt negative cognitions, behavior and affect resembling the mother's. Lastly, it is hypothesized that their deficient skills and styles, in addition to negative cognitions, behavior and affect will elevate the child's risk of developing depression (Goodman & Gotlib, 1999). Children from infancy through adolescence seem to show functioning that broadly mirrors their mother's depressive functioning in cognitions, behavior and emotion (Goodman & Gotlib, 1999). Maternal depression has been found to be associated with a range of impaired parenting behaviors, and depressed mothers tend to alternate between permissive parenting

and harsh, punitive behavior in disciplinary situations (Goodman & Tully, 2006). Lovejoy, Graczyk, O'Hare, and Neuman (2000) conducted a meta-analysis of 46 observational studies of maternal depressive symptoms and parenting behavior, confirming a moderate association between the two. Maternal depression was most strongly associated with hostility and irritability toward the child, and to a lesser extent disengagement, while only weakly associated with positive parenting behaviors (Lovejoy et al., 2000). The effect sizes of the studies investigated did not differ significantly between those using self-reported depressive symptoms and clinical interviews (Lovejoy et al., 2000). Hence, clinical diagnosis is not necessary for negative parent effects of depressive symptoms to be observed (Lovejoy et al., 2000). Kluczniok et al. (2016) found that mothers in remission from depression, compared to healthy controls, showed reduced sensitivity and structuring in addition to increased hostility when observed in interaction with their school-aged children. This suggests that impaired parenting behavior associated with depression may persist after the acute depressive symptoms are alleviated (Kluczniok et al., 2016).

The models fourth and last mechanism concerns the contextual stressors in the lives of children whose mother is depressed. Stressful life events and depression are correlated, and the causality may go both ways (Goodman & Gotlib, 1999). For instance, Goodman et al. (2011) found larger effect sizes in their meta-analysis for the association between maternal depression and child psychopathology in study populations of families living in poverty. If this is due to depression being more severe in these populations, or children being exposed to more stressors related to poverty is not clear (Goodman et al., 2011). Risk factors such as low social support, financial stress and family adversity are all correlated with parental depression (National Institute of Child Health and Human Development Early Child Care Research Network, 1999). Neighborhood disadvantage is correlated with child mental health symptoms (Kemp, Langer, & Tompson, 2016). In a rare longitudinal experiment (N=794), it was found that in randomly selected families assisted in moving from high-poverty to selected low-poverty neighborhoods, both parents and children reported significantly improved mental health after three years (Leventhal & Brooks-Gunn, 2003). The families were compared both to families moving without geographical restriction and families staying in the high-poverty neighborhood (Leventhal & Brooks-Gunn, 2003). Follow-up of the participating adults showed long-term improvements in mental and physical health, in addition to subjective well-being, after 10-15 years (Ludwig et al., 2012).

1.1.2 Moderators

Goodman and Gotlib (1999) have identified three main moderators in their model, potentially affecting the association between maternal depression and negative child outcomes, also influencing and being influenced by maternal depression as seen in figure 1.1. The first moderator is the father, who can be adding to the risk if absent or having psychopathology, or represent a protective factor if he is healthy, involved and supportive (Goodman & Gotlib, 1999). Paternal depression is highly correlated with maternal depression (Wee, Skouteris, Pier, Richardson, & Milgrom, 2011), and a recent meta-analysis estimated prevalence of paternal depression to be 8.4% in the pregnancy and first year after birth (Cameron, Sedov, & Tomfohr-Madsen, 2016). A meta-analysis of studies investigating associations between paternal depression and parenting behaviors found the association to be significant, but small (Wilson & Durbin, 2010). In the event of a depressed mother, a father with psychopathology would add to the genetic vulnerability inherited by the child in addition to the more negative parenting behaviors (Phares & Compas, 1992). A study of adolescent girls' self-reported symptoms (N=862) and their own reports of their parents' psychopathology found additive effects of perceived maternal and paternal psychopathology in predicting adolescent anxiety and depression (Rasing, Creemers, Janssens, & Scholte, 2015). In addition, perceived paternal psychopathology was found to moderate the association between perceived maternal psychopathology and both adolescent anxiety and depression (Rasing et al., 2015).

As the second moderator of risk, Goodman and Gotlib (1999) point to the importance of the course of maternal depression in addition to timing of the first episode in terms of the child's developmental stage. They claim that the older the child is at first exposure to maternal depression, the less vulnerable the child will be, due to more matured behavioral systems and more developed competencies for successful coping (Goodman & Gotlib, 1999). In support of this, they found statistically significant negative correlations between the mean age of children studied and the magnitude of the effect sizes for the relation between maternal depression and child internalizing and externalizing problems in two later meta-analyses (Connell & Goodman, 2002; Goodman et al., 2011). Still, the studies included rarely control for timing of *first* exposure to maternal depression, complicating the interpretation of these results (Goodman et al., 2011). There are studies of timing identifying the first year of life as a sensitive period for effects of maternal depression (Bagner, Pettit, Lewinsohn, & Seeley, 2010). Contrary to this, a prospective longitudinal study (N=937) identify a potential

sensitive period in children initially exposed to maternal depression between ages two and five, compared to both exposure in the first year of life and later initial exposure (Naicker, Wickham, & Colman, 2012). These findings indicate that timing is relevant, even though the conclusions as to how are still diverse. Regarding the course of maternal depression, symptom severity and chronicity might be more relevant for child outcome than clinical diagnosis (Goodman, 2007). One longitudinal study (N=4,953) found main effects of both severity and chronicity of maternal depressive symptoms, as well as an interaction effect between the two when predicting child behavioral problems at five years (Brennan et al., 2000). As stated above, depression is frequently recurrent, and it has been found that mothers with elevated depressive symptoms early in their children's lives are highly likely to continue reporting depressive symptoms during the preschool years (Horwitz, Briggs-Gowan, Storfer-Isser, & Carter, 2009).

The third theoretical moderator will be the main focus of the present study. As mentioned, Goodman and Gotlib (1999) propose, in line with the diathesis-stress model, that some children are more vulnerable than others to the exposure to risk, meaning that some characteristics of the child moderate the association between maternal depression and negative child outcomes. They specify child gender and temperament in addition to intellectual and social-cognitive skills as the relevant characteristics (Goodman & Gotlib, 1999). Girls and boys may be affected by maternal depression in different ways, for instance through differences in heritability or parent-child interactions (Goodman & Gotlib, 1999). Regarding temperament, children with a lower sensitivity to change, higher threshold for stimulation and more flexible response style are hypothesized to be less vulnerable to maternal depression (Goodman & Gotlib, 1999). Children's intelligence and level of social-cognitive skills also represent a moderating factor in this model, suggesting that higher intelligence and better social-cognitive skills are protective factors (Goodman & Gotlib, 1999).

When developing the model, the empirical support for these child characteristics' moderation effect was very limited (Goodman & Gotlib, 1999). The literature investigating maternal depression as a risk for child development has continued to grow, but few have investigated potential moderation effects of child characteristics (Goodman et al., 2011). The question of moderation is important in identifying subgroups of increased risk, possibly with different underlying mechanisms which in turn may be subjects of interest for further studies

(Goodman et al., 2011). The present paper aims to investigate whether these theoretically proposed child characteristics moderate the association between concurrent maternal depressive symptoms and preschool children's internalizing and externalizing problems. Relevant literature will be reviewed before presenting the hypotheses.

1.2 Literature Review

1.2.1 Maternal Depression Affecting Child Development

Goodman and Gotlib (1999) underscore the importance of investigating a broader set of child outcomes, as the transferred vulnerability from maternal depression may be more general and not specific to developing depression. Supporting this, Goodman et al. (2011) found in their meta-analysis that the association between maternal depression and internalizing problems was not significantly stronger than with externalizing problems, even though depression is on the internalizing spectrum. In a recent review, parental depression was found to show a pattern of multifinality, meaning that child outcome was diagnostically diverse, not specific to depression (van Santvoort et al., 2015). Diagnostic categorization is disputed, and when it comes to research on children and adolescents, there is empirical support for using broad groupings of disorders, as there is systematic comorbidity for clusters of diagnoses (Achenbach et al., 2016). Hence, most studies report differences in child internalizing and externalizing problems, not prevalence of specific diagnoses.

Independent effects of prenatal, postnatal and later concurrent maternal depressive symptoms on child internalizing and externalizing problems have all been reported (Lahti et al., 2017). Traditionally, the postnatal period has been heavily prioritized in this research area, but prenatal effects have also been recognized in more recent years (O'Connor et al., 2016). The notion that postnatal depression is more prevalent than prenatal and later depression during women's fertile years has been challenged (Eberhard-Gran, Tambs, Opjordsmoen, Skrondal, & Eskild, 2004). Woolhouse, Gartland, Mensah, and Brown (2015) found maternal depression to be more prevalent when children were four years old compared to the first twelve months postpartum, stressing the importance of also screening mothers after the perinatal period. A longitudinal study spanning 20 years found maternal depression to be continually associated with depressive symptoms and acute and chronic stress in children and youth (Hammen, Hazel, Brennan, & Najman, 2011).

Several longitudinal studies report higher levels of internalizing and externalizing problems in children of prenatally depressed mothers (Field, 2011). In their prospective longitudinal study in Finland (N=2,296), Lahti et al. (2017) found that higher maternal prenatal depressive symptoms predicted higher levels of externalizing, internalizing and total problems in early childhood. They also found that concurrent maternal depressive symptoms partially mediated the effects of prenatal depression, and that combined pre- and postnatal depressive symptoms showed additive effects on child internalizing and total problems (Lahti et al., 2017). These findings correspond well the Avon Longitudinal Study of Parents and Children (ALSPAC) (N=2,891) finding a significant association between prenatal maternal depressive symptoms and maternal reports of child emotional and behavioral problems at age 10-11 (Leis, Heron, Stuart, & Mendelson, 2014). This association held statistical significance also when controlling for exposure to later maternal mental health problems. In another comparable study, Generation R (N=2,698), Velders et al. (2011) found that the association between exposure to prenatal depression and child internalizing and externalizing problems was not independent of exposure to postnatal hostility, suggesting that parent-child interaction may be necessary for the association to hold.

A recent publication from the Norwegian Mother and Child Cohort Study (MoBa, N=11,599) replicated previous findings of independent effects of pre- and postnatal as well as concurrent maternal depressive symptoms on child internalizing and externalizing problems in preschool children (Gjerde et al., 2017). However, when controlling for confounding familial factors by sibling comparison, only concurrent depression still had a significant effect (Gjerde et al., 2017). Similarly, Closa-Monasterolo et al. (2017) found that children's internalizing and externalizing problems at eight years old were highest when mothers reported both current mental health problems and postnatal depression. The group of children whose mothers only reported postnatal- and not later mental health problems did not differ from the children having mothers without depression (Closa-Monasterolo et al., 2017). In the Millennium Cohort study (N=17,160), Flouri, Ruddy, and Midouhas (2016) confirmed a longitudinal association between concurrent maternal depression and both child internalizing and externalizing problems from preschool to the end of primary school. The measurement intervals were at 3, 5, 7 and 11 years, and the association was robust when controlling for child gender and ethnicity, as well as several measures of socio-economic status (Flouri et al., 2016). In sum, the reviewed studies suggest a partially additive effect of perinatal and later concurrent depression. However, the effect seems driven by later concurrent depressive

symptoms. In a sample of patients with Major depressive disorder (N=380), the recurrence rate in 15 years was found to be 85% (Mueller et al., 1999). The median time interval from remission to recurrence was 2.5 years, and women were 43% more likely to experience recurrence compared to men (Mueller et al., 1999). Hence, it is highly likely that children whose mothers suffers from pre- and postnatal depression go on to be exposed to more depressive episodes during their developmental years (c.f. Horwitz et al., 2009).

As previously mentioned, impaired parent behaviors are found also after remission from depressive symptoms (Kluczniok et al., 2016), and Goodman and Garber (2017) recommend specifically training parent behaviors when treating mothers with depression. Some studies have investigated whether remission from maternal depression itself may positively impact child outcomes. Reviewing 10 relevant studies, Gunlicks and Weissman (2008) found support for improvements in child symptoms and functioning following remission of parental depression. Wickramaratne et al. (2011) followed 12 year old children in three-month intervals for one year after maternal remission from depression (N=80), and found that self-reported child psychiatric symptoms and parent-reported child internalizing and externalizing problems all decreased during that time. Children of non-remitting mothers showed significant increases in reported externalizing problems (Wickramaratne et al., 2011). Child functioning was also assessed with Children's Global Assessment Scale, and only children of early-remitting, not late-remitting, mothers significantly improved on this measure in one year (Wickramaratne et al., 2011). This supports the notion that duration and severity of maternal depression are affecting child outcome (Wickramaratne et al., 2011). A more recent meta-analysis of nine randomized-controlled trials on psychotherapy for maternal depression, also indicates that child mental health is improved through maternal treatment (Cuijpers, Weitz, Karyotaki, Garber, & Andersson, 2015). The quality of the existing studies is criticized, but the results supports that providing psychotherapy for parents benefits their children (Cuijpers et al., 2015).

1.2.2 Characteristics of the Child as Potential Moderators

As was defined above, moderator variables are third variables that affect the association between two other variables. If child characteristics moderate the association between maternal depression and child internalizing and externalizing problems, children differing in regards to those characteristics will have differences in strength, and possibly direction, of the

association (Aiken & West, 1991). Moderation by dichotomous variables (i.e. gender) means that the association between the independent and dependent variable is different for each of the two groups (i.e. male and female). When investigating moderation by a continuous variable (i.e. temperament), the principles are the same (Aiken & West, 1991). The association between maternal depression and child outcome changes depending on the level of that third variable (i.e. level of temperamental emotionality), meaning that maternal depression and temperament interact to predict child outcome (Aiken & West, 1991).

Gender

In their meta-analysis, Goodman et al. (2011) found a stronger association between exposure to maternal depression and internalizing problems for girls compared to boys. The gender difference was independent of the age of the children, and not found for externalizing problems or general psychopathology. They specifically encourage future researchers to include gender in models of association between maternal depression and internalizing problems (Goodman et al., 2011).

Gender was found to moderate the association between early maternal depressive symptoms and toddlers' felt security attachment in a recent study using conditional latent growth models (Beeghly et al., 2017). Rapid increase in maternal depressive symptoms was associated with lower felt attachment security at 18 months for males, but not females, indicating that boys may be more vulnerable to the early exposure to maternal depression (Beeghly et al., 2017). Studying mother-infant interaction, Weinberg, Olson, Beeghly, and Tronick (2006) found three month old boys to be more vulnerable to high levels of maternal depressive symptoms compared to girls, showing mutual regulatory problems in a reunion episode between mother and child. As part of a comprehensive longitudinal study of the transactional relationship between maternal depression and externalizing problems, Choe, Sameroff, and McDonough (2013) found a moderating effect of gender so that maternal depressive symptoms at seven months postpartum only predicted boys', not girls', externalizing problems as toddlers (33 months). Another longitudinal study (N=191) found concurrent maternal depression to predict internalizing and externalizing problems for both genders at age 16-17 (Korhonen, Luoma, Salmelin, & Tamminen, 2012). However, previous pre- and postnatal maternal depressive symptoms only predicted boys' self-reported externalizing problems and parent reported social competence (Korhonen et al., 2012). The outcome measures are not the same

in these studies, but together they suggest that boys are more vulnerable to the early exposure to maternal depression compared to girls.

Blatt-Eisengart, Drabick, Monahan, and Steinberg (2009) found a three-way interaction effect of gender and time for the association between maternal depression and child externalizing symptoms from the age of two years to first grade. The association between maternal depression and externalizing symptoms was significantly weakening with age for boys and amplified with age in girls (Blatt-Eisengart et al., 2009). A longitudinal study of children from 10 to 15 years of age (N=1,294) similarly found that self-reported internalizing problems increased for girls and decreased for boys with age (Jenkins & Curwen, 2008). Girls were also found to show a stronger association between concurrent maternal depressive symptoms and internalizing problems (Jenkins & Curwen, 2008). In the ALSPAC study (N=7,959), gender was found to moderate the association between both pre- and postnatal exposure to maternal depression and later youth depression (Quarini et al., 2016). At age 18, exposed girls were significantly more likely to suffer from depression compared to exposed boys, but the gender moderation was not found when the children were 12 years old (Quarini et al., 2016). Taken together, these studies suggest that moderation effects of gender are dependent of the age of the children at the time of exposure to maternal depression, with boys being more vulnerable to early exposure and girls more vulnerable to later exposure. When it comes to specifically developing internalizing problems (e.g. depression), girls may be generally more vulnerable to exposure to maternal depression than boys (c.f. Goodman et al., 2011; Quarini et al., 2016).

Temperament

Temperament is a term used to describe individual differences in dispositional traits in infants, children and adolescents (Rettew & McKee, 2005). Despite decades of research, the definition of temperament is still subject to considerable debate (De Pauw & Mervielde, 2010). There is general consensus regarding some key components of temperament, namely that it has a strong genetic or neurobiological basis, manifestation from infancy onward, and that it is at least moderately consistent across time and situations (De Pauw & Mervielde, 2010). A substantial challenge in comparing or summarizing research findings involving temperament, is that there are multiple organizing systems with partially overlapping constructs given different names (Rettew & McKee, 2005). The relation between temperament and personality is also an unresolved matter (Rettew & McKee, 2005). The

definitions are sometimes interchangeable, and McCrae et al. (2000) argue that the terms refer to the same construct. Others, however, define temperament as a distinct genetic component of the more comprehensive personality term, or see it as a precursor to the later developing personality (Rettew & McKee, 2005). Generally, it seems the more modern view is that temperament and personality are more similar than different (Kushner, 2015). Researchers concerned with child development, however, tend to use the term to describe early-appearing, strongly genetic predispositions prior to personality development (Rettew & McKee, 2005).

Research on temperament and psychopathology have traditionally belonged to different disciplines, long existing as parallel research areas (Kushner, 2015). Studies combining the two mostly report correlations between a specific dispositional trait and a category of psychopathology, not investigating the broader picture (Tackett, 2006). The vulnerability or predisposition model is one of several theoretical models for conceptualizing the relationship between dispositional traits and psychopathology, suggesting that certain traits may entail greater risk for developing specific forms of psychopathology (Tackett, 2006). This view corresponds well with the diathesis-stress and social-push models, positing that predispositions or vulnerabilities interact with stressors to cause psychopathology (Kushner, 2015). If child temperament moderates the association between maternal depression and child internalizing and externalizing problems, this is in line with the model by Goodman and Gotlib (1999), which is informed by the diathesis-stress model and vulnerability perspective of temperament.

Only a few studies have examined the moderator effect of temperament on the association between parental depression and child internalizing or externalizing problems (Hummel & Kiel, 2015). Gartstein and Bateman (2008) investigated the independent and interactive effects of maternal depressive symptoms and infant temperament (negative emotionality and regulatory capacity) on toddler depression-like symptoms (a component of internalizing problems). They found infant negative emotionality to moderate the association between maternal depression and toddler depression-like symptoms (Gartstein & Bateman, 2008). All toddlers showed high symptom levels when maternal depression was high. The difference between the groups appeared when maternal depression was low. Toddles previously rated with lower infant negative emotionality had lower symptom levels, while toddlers rated with higher infant negative emotionality showed symptom levels comparable to when maternal

depression was high (Gartstein & Bateman, 2008). Hence, toddlers rated lower on infant negative emotionality showed a stronger association between maternal depression and toddler depression-like symptoms. Children rated high on negative emotionality had high scores of depression-like symptoms regardless of maternal depression (Gartstein & Bateman, 2008). In a later similar study, Jessee et al. (2012) used both parent report, teacher report and temperament observations to study moderator effects of temperament at the age of five. Parent-rated child negative affect and observed child incongruous negative emotionality was found to moderate the effect of maternal depression, so that higher negative emotionality gave a stronger association between maternal depression and child total behavioral problems (internalizing + externalizing problems) (Jessee et al., 2012). In both studies, high temperamental emotionality predicts high symptom levels for the child, but the interaction effects with maternal depression are opposite. Jessee et al. (2012) also found parent-rated child surgency (activity) to moderate the effect of both maternal and paternal depressive symptoms on child total behavioral problems. Children high on the surgency measure had a significant association between parental depression and behavior problems, while the association was non-significant for children with low surgency (Jessee et al., 2012).

In an attempt to model the transactional mechanisms in the relation between maternal depression and toddler internalizing problems, Hummel and Kiel (2015) developed and tested a moderated mediation model. Maternal behavior (maternal warmth and intrusiveness) was hypothesized to mediate the association, while toddler temperament (negative emotionality) and gender were hypothesized to moderate both the association between maternal depression and -behavior and between maternal behavior and toddler internalizing problems (Hummel & Kiel, 2015). They found that only for boys with low negative emotionality, the association between maternal depressive symptoms and child internalizing problems was mediated through low maternal warmth (Hummel & Kiel, 2015). Maternal intrusiveness was not found to be associated with maternal depressive symptoms under any conditions. However, a significant three-way interaction effect was found between maternal intrusiveness, toddler negative emotionality and gender in relation to internalizing problems (Hummel & Kiel, 2015). This was found to imply that for girls low on negative emotionality, maternal intrusiveness and internalizing problems were positively related, whereas the relation was negative for girls high on negative emotionality (Hummel & Kiel, 2015). Taken together, these studies support the theory that different aspects of child temperament make children more and less vulnerable to the impact of parental depression, but moderation effects point in

somewhat different directions. The studies are also limited by only including one or two dimensions of temperament each.

Inhibitory Control

Despite limited empirical evidence, Goodman and Gotlib (1999) hypothesized that the child's intellectual and social-cognitive skills would moderate the effects of exposure to maternal depression. Social information processing appears to be a key to developing social-cognitive skills, often impaired in children with mild intellectual disabilities (van Nieuwenhuijzen & Vriens, 2012). Social information processing relies on higher cognitive control functions, often referred to as executive functions (van Nieuwenhuijzen & Vriens, 2012). This dependency is supported in a recent review consistently finding that social interactions can influence the development of executive functions (Moriguchi, 2014).

Executive functions refers to a set of effortful, top-down cognitive processes that enable adaptive responses to new or ambiguous situations, and they are needed for goal-directed behavior (Diamond, 2013). Through confirmatory factor analysis, Miyake et al. (2000) found that the three core executive functions: inhibition, working memory and cognitive flexibility are moderately correlated, but clearly separable, in an adult population. Later studies on children using the same methods have found that the executive functions are more unitary in preschool children, before developing a more fractured structure with age (Hughes, 2011). The sub-function of inhibitory control appears to develop fairly early during childhood, enabling the child to pursue long term goals by inhibiting preferred or automated responses (Lagasse et al., 2016). These inhibitory abilities continue to be important while cognitive flexibility and working memory develop during middle childhood and adolescence (Lagasse et al., 2016). Measuring executive functions in children require an explicit awareness of this development, as aspects of executive functions are not expected to be mature in younger children (Lagasse et al., 2016). Inhibitory control rapidly increases during the preteen years (Fjell et al., 2012), and can be meaningfully measured in preschool children (Diamond, Barnett, Thomas, & Munro, 2007). Executive functions have been found to have a strong genetic component, and once matured, individual differences in executive functioning are relatively stable over time (Miyake & Friedman, 2012).

In adults, impaired executive functioning has been associated with many forms of psychopathology, including depression and schizophrenia (Diamond, 2013). In a meta-

analysis of studies investigating adults in their first episode of major depressive disorder, significant reductions in all aspects of executive functions were found, in addition to attention and other cognitive measures (Lee, Hermens, Porter, & Redoblado-Hodge, 2012). Children with major depressive disorder have also been found to do significantly worse than healthy controls on tasks measuring executive functions in a recent meta-analysis (S. Wagner, Muller, Helmreich, Huss, & Tadic, 2015). Whether these associations are due to executive functions being an early marker of vulnerability, or if internalizing and externalizing problems impair executive functions is not determined (C. Wagner, Abramson, & Alloy, 2015). Brunnekreef et al. (2007) found severity of both internalizing and externalizing problems to be associated with poorer outcomes on six different measures of information processing in 10-12 year old children, including response inhibition. In a cross-cultural study, Olson et al. (2011) found low levels of inhibitory control to predict externalizing problems in preschool children across cultures. The inverse relationship between inhibitory control and externalizing problems has also been found to increase with age in preschool children (Utendale & Hastings, 2011). In a sample of children with executive problems, Tillman, Brocki, Sorensen, and Lundervold (2015) found support for their hypothesis that the executive functions develop hierarchically as outlined above. In addition, they found problems with inhibition and sustained attention to be more salient in early childhood compared to adolescence, implying that executive functions deficiency in this group is more manifest in executive functions currently in active development (Tillman et al., 2015).

Good executive functioning has been suggested as a protective factor when it comes to developing internalizing and externalizing problems, but few studies have included it as a potential moderator of risk from parental depression (Flouri et al., 2016). According to the review by Hughes (2011), an inverse correlation is found between exposure to maternal depression and executive functioning in preschool children, while this association is absent when investigating older children or adolescents. In a later longitudinal study (N=126), Hughes, Roman, Hart, and Ensor (2013) found level and chronicity of maternal depressive symptoms to predict poorer outcome in child executive functions across four years from age two to six. In their extensive longitudinal study (N=17,160), Flouri et al. (2016) conclude that children with depressed mothers and cognitive impairments may be especially vulnerable to developing internalizing and externalizing problems. Their study did not include inhibitory control, but following children from preschool age to the end of primary school, they found working memory deficits to moderate the association between maternal depression and both

child internalizing and externalizing problems. The associations were stronger for children with lower working memory capacity (Flouri et al., 2016).

1.3 The Present Study

Based on the model by Goodman and Gotlib (1999), a more narrow model is extracted to represent the hypotheses of the current paper as shown in figure 1.2. In summary, the empirical support for the presence of concurrent maternal depressive symptoms to be an individual risk factor for negative child outcomes is considerable (c.f. Gjerde et al., 2017; Goodman et al., 2011). Thus, an association between concurrent maternal depressive symptoms and both internalizing and externalizing problems in preschool children is expected. The results from empirical studies regarding each of the theoretically proposed moderators are more diverse, however, underpinning the relevance of investigating these.

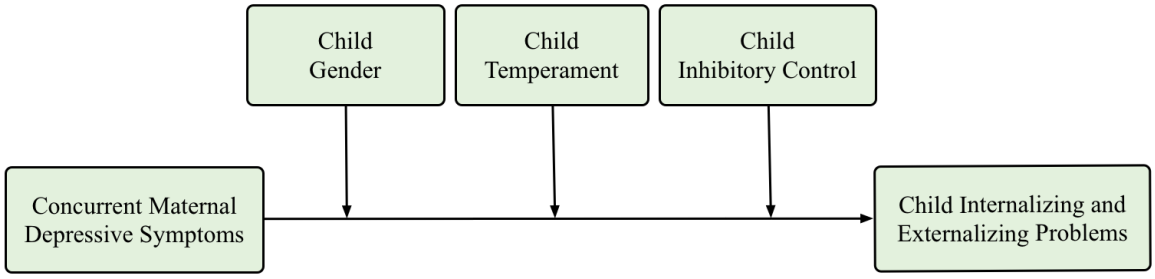

Figure 1.2 *Adapted model illustrating the moderation of the association between concurrent maternal depressive symptoms and child internalizing and externalizing problems by specific child characteristics.*

The direction of a potential gender moderation of this association is not empirically established. The meta-analysis by Goodman et al. (2011) found the association between maternal depression and internalizing problems to be stronger for girls, independent of age. Hence, girls are expected to show a stronger association between concurrent maternal depressive symptoms and internalizing problems in the present sample. Still, there is reason to suspect an age-dependent moderator effect of gender, especially regarding externalizing problems (c.f. Blatt-Eisengart et al., 2009). As the present thesis investigates preschool children between five and six years old, it is expected that the direction of moderation found in studies of younger children is replicated. Thus, a stronger association between concurrent maternal depressive symptoms and externalizing problems is expected for boys (c.f. Choe et al., 2013).

Regarding temperament, the literature is even less clear. To be able to investigate a comprehensive measure of temperament, the present study will use the EAS model developed by Buss and Plomin (1984), comprising Emotionality, Activity, Sociability and Shyness. Based on the theory and empirical studies reviewed, temperamental emotionality is expected to moderate the association between concurrent maternal depressive symptoms and child internalizing and externalizing problems. Whether children with low or high levels of emotionality will show a stronger association is not specified because of contradicting previous findings (c.f. Gartstein & Bateman, 2008; Jessee et al., 2012). A stronger association between concurrent maternal depressive symptoms and child internalizing and externalizing problems is expected for children with high levels of temperamental activity (c.f. Jessee et al., 2012). When it comes to Sociability and Shyness, the predictions based on theory are that the association will be stronger for children high on shyness and low on sociability (c.f. Goodman & Gotlib, 1999)

The last hypothesized moderator is inhibitory control. Based on the theory and literature reviewed, children with poorer executive functions are expected to be more vulnerable to the negative effects of maternal depression (c.f. Flouri et al., 2016; Goodman & Gotlib, 1999). Thus, the associations between concurrent maternal depressive symptoms and both child internalizing and externalizing problems are expected to be stronger for children with low inhibitory control.

2 Methods

2.1 Participants

The present study is part of PhD Tone Kristine Hermansen's doctoral project at the Cognitive Developmental Research Unit (EKUP), where professor Annika Melinder is the project manager. All participants in the PhD project were recruited from The Norwegian Mother and Child Cohort Study (MoBa). MoBa is a prospective population-based pregnancy cohort study conducted by the Norwegian Institute of Public Health. The current study is based on version eight of the quality-assured data files released for research. Both the cohort study in general and the doctoral project are approved by the Regional Committee for Medical Research Ethics (REK). The EKUP doctoral project is exploring cognitive and emotional differences between children exposed to antidepressant medication (SSRI) or untreated depression during pregnancy.

Originally, a sub-sample of the MoBa-study was invited to participate in the doctoral project. The sub-sample reflected three groups of women with children born in 2008 and 2009 (N=667). Groups 1 and 2 consisted of women who reported being depressed during pregnancy and who were either using or not using antidepressants, respectively. The third group consisted of women who reported not being depressed during pregnancy. From this invited sample approximately 15% agreed to participate in the study (G1 N=28; G2 N=42; G3 N=33), adding up to a total of 103 participants. For the purpose of the present study, the participants are no longer divided into groups based on prenatal depression exposure, rather concurrent maternal depressive symptoms are regarded on a continuum. Seven participants were excluded for missing data on the outcome variable (Child Behavior Checklist), giving a total of N=96. At the time of birth, the mean age of the mothers was 31.6 years (SD=4.8). At the time of testing, the mean age of the children was 68.1 months (SD=5.6, 49 girls). The number of participants varies somewhat in different analyses due to missing data.

Based on the meta-analysis by Goodman et al. (2011), the effect sizes for the present study were expected to be small. Goodman et al. (2011) found maternal depression to account for between 1% and 6% of the variance in child outcomes. The small effect sizes do not necessarily imply that maternal depression is not important for child outcome, but rather that mechanisms underlying child development are complex and multifaceted (Goodman et al.,

2011). Given a small effect size (i.e. Cohen's d=.20), and a significance level of $p \leq .05$, sample size should be at least N=88 for it to be likely (i.e. 95% chance) to find an effect if it is truly there (Faul, Erdfelder, Buchner, & Lang, 2009). The power estimate is derived using G*Power, with parameters specified for a regression model with three predictor variables.

2.2 Measures

2.2.1 Maternal variables

Depressive Symptoms

Beck Depression Inventory II (BDI-II; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) is a self-report measure of current depressive symptoms. It contains 21 groups of four statements each, where the respondent picks the statement in each group best describing how they have felt in the last week. The scale is cumulative, giving a total score between 0 and 63 indicating severity of depressive symptoms (Bech, 1993). Cut-off scores are based on American norms, and a score of 14-19 indicates mild depression, 20-28 moderate and 29-63 severe depression (Siqveland & Kornør, 2011). In their review of the properties of the Norwegian version of BDI-II, Siqveland and Kornør (2011) found that it shows good psychometric properties in an adult population. They report test-retest reliability of r=.77, internal consistency of Chronbach's α=.86-.91 and convergent validity of r=.71-.84 when correlating BDI-II with other self-report measures of depression. In the present sample, internal consistency is found to be high (α=.91).

2.2.2 Child Variables

Internalizing and Externalizing Problems

Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2000) is by far the most frequently used rating scale for measuring child and adolescent internalizing and externalizing problems for research purposes (Achenbach et al., 2016). In the present study, both the preschool (1½ - 5 years) and youth (6-18 years) versions are used, depending on the child's age at the time of assessment. Both versions give three main problem scales, comprised of internalizing problems (consisting of the subscales *anxious/depressed*, *withdrawn/depressed* and *somatic complaints,* in the preschool version *emotionally reactive* comes in addition), externalizing problems (consisting of the subscales *aggressive behavior* in addition to *attention problems* or *rule-breaking behavior* in the preschool and youth versions respectively), and total problems (*internalizing + externalizing problems*). In the

present study, the internalizing and externalizing problem scales are used. The scales are based on 100 or 120 questions of specific behaviors rated on a three point likert scale labelled "not true", "somewhat or sometimes true" and "very true or often true". To allow for cross-scale comparisons, the scores are reported in standardized T-scores (mean=50, SD=10). The psychometric properties of the preschool form (1½ - 5 years) used in this study has not been documented in a Norwegian population (Kornør & Jozefiak, 2012). In the American manual, Achenbach and Rescorla (2000) report a mean test-retest reliability of r=.85 and an inter-parent agreement of r=.61, without finding any significant gender differences in tendency to report problems. The internal consistency is high, with α=.89 for internalizing and α=.92 for externalizing problems (Achenbach & Rescorla, 2000). The psychometric properties of the earlier version CBCL 4-18 has been studied in Norwegian samples, supporting the construct validity of the Norwegian version through confirmatory factor analysis (Kornør & Jozefiak, 2012). In the present sample, the internal consistency is found to be high with α=.81 for externalizing problems and α=.79 for internalizing problems.

Temperament

The Emotionality, Activity and Shyness Temperament Questionnaire (EAS; Buss & Plomin, 1975) is regarded one of the four most salient measures in temperament literature (De Pauw & Mervielde, 2010). The instrument was originally designed to measure three different dimensions of temperament, Emotionality, Activity and Shyness. Buss and Plomin (1984) later added Sociability, and the four factor structure has been confirmed in a Norwegian sample of N=921 (Mathiesen & Tambs, 1999), and an English sample of N=7429 (Bould, Joinson, Sterne, & Araya, 2013). Employing a five point likert scale, the respondent rates the extent to which different statements apply to their child's behavior in the last two months. The scale presents the alternatives "very typical", "quite typical", "neither/nor", "not so typical" and "not at all typical". The dimensions of EAS show good stability over time, but also significant expected age trends of increased Emotionality and Shyness and decreased Activity and Sociability with increasing age (Mathiesen & Tambs, 1999). The version used in the present study is a short form developed by MoBa based on the data from Mathiesen and Tambs (1999). It consists of 12 items (3 x 4) instead of 20 (5 x 4). According to the instrument documentation provided by MoBa, the dimensions of the abbreviated instrument are found to have correlations with the dimensions of the original instrument between r =.92-.96 (Division of Mental Health PHBU, 2009). The short form is found to have poorer internal

consistency than the full instrument, which can be expected as the items are chosen for heterogeneity (Division of Mental Health PHBU, 2009). In the present sample, the internal consistency for each dimension is found to be somewhat higher than the estimations reported by MoBa, with α=.63-.68.

Inhibitory Control

Flanker-task (child-friendly version developed from Eriksen and Eriksen (1974))

The original Flanker task was developed by Eriksen and Eriksen (1974), and varieties of this paradigm is a common measure of inhibitory control (Diamond, 2013). In order to create a child-friendly version of the Flanker task, the traditional arrows were replaced by stimuli from the Attentional Network Task (ANT) for children, developed by Rueda et al. (2004). Participants were introduced to the task as a computer game where they were supposed to catch cartoon animals. The stimulus consisted of five identical cartoon animals in a row, where the middle animal was the target stimulus and the four flankers were distractors. The participants were instructed to focus on the target animal, ignoring the flankers, and press the arrow key corresponding to the orientation of this animal to catch it as fast as possible. In each trial, the flankers were either oriented in the same direction as the target (congruent trial) or in the opposite direction (incongruent trials). Accuracy and response times were measured for each trial, half of which were incongruent. Lower accuracy and longer response times were found for the incongruent compared to the congruent trials, indicating that the paradigm worked as intended and supporting the reliability of the instrument for the age group. In the present analysis, accuracy percentage for the incongruent trials is used as the measure of inhibitory control, as accuracy has been found to be a more sensitive measure than reaction time in young children (Diamond et al., 2007).

2.3 Procedure

Through questionnaires provided by MoBa, the mothers responded to the short version of the temperament instrument EAS when the children were three years old. The children attended cognitive testing at the EKUP laboratory at five to six years of age, including the Flanker task. The mothers filled out CBCL and BDI-II during this test session.

2.3.1 Ethical Considerations

Children in general and people suffering from mental disorders are considered vulnerable groups in research (Ruyter, 2014). Including vulnerable participants can be justified when the research is relevant and potentially beneficial for the particular groups (Ruyter, 2014). Two thirds of the mothers included in the present study were invited based on reports of antidepressant medication and/or depressive symptoms during pregnancy. Still, this group is not considered to have reduced capacity to consent, and the mothers gave written informed consent on behalf of themselves and their child. A child-friendly version of the informed consent was provided, and mothers were encouraged to read it together with their child before attending the test session. To ensure voluntary participation from the children, they were explicitly informed by test managers that they could choose not to participate in any part of the assessment. The current study did not involve exposing the participants to risk. However, participating in a study describing potential negative effects for their children may cause worry for some of the mothers. Before and during the test session, participants were given the opportunity to ask questions and be informed on the current knowledge status in the field by test managers. This study concerns sensitive topics regarding mental health, which requires particular care in how to record and store personal information (Fossheim, 2015). Anonymization and restricted access to the data were measures taken to ensure confidentiality.

2.4 Analysis

2.4.1 Missing Data

Out of the 96 participating pairs of mother and child, 15 had not filled out the temperament questionnaire at three years, giving a total of N=81 for the analyses involving child temperament. Five participants had missing data on the Flanker task, giving a total of N=91 for the analyses regarding the moderating effect of child inhibition. Two further participants with low scores on this measure were considered excluded as outliers. However, the participants were included, as the scores were not very low compared to what accuracy percentage can be expected in this age group. In addition, the participants had significantly higher scores for the congruent condition, indicating that the paradigm worked as intended also for these two children. For the BDI-II and gender variables, no data was missing (N=96).

2.4.2 Variable Preparations

The CBCL was scored using the ASEBA Windows software for computerized scoring, calculating T-scores (M=50, SD=10) for the main scales of internalizing and externalizing problems. For the EAS, the necessary items were reversed before computing mean scores for each of the four different temperament dimensions. Accuracy on the Flanker task was denoted by percentage, with possible scores ranging from 0 to 1 (.50 being 50% correct). Gender was coded 0 = male, 1 = female. For the BDI-II, the total score was used (0-63). To avoid issues with multicollinearity, scores of the continuous independent variables (BDI-II, EAS, Inhibitory Control), were standardized (M=0, SD=1) before computing the interaction terms (BDI-II x moderator).

2.4.3 Data Inspection

Histograms illustrating the distributions, in addition to normal probability plots, were visually inspected for each continuous predictor variable. The distribution of scores for concurrent maternal depressive symptoms (BDI-II) was positively skewed. This was expected for a depression measure in a non-clinical sample, as many participants will report no or few depressive symptoms. The distribution of scores for inhibitory control was negatively skewed, meaning that many participants had a high percentage of correct responses. Parametric statistical tests are based on a set of assumptions, including normally distributed independent variables (Pallant, 2013). Mathematical transformation of data to comply with the assumptions is controversial, but with some authors strongly supporting this practice (Pallant, 2013). Based on the recommendations by Tabachnick and Fidell (2013), logistic transformation was attempted, without improving the shape of the distributions. The scores were considered best kept in their original form.

Residuals plots were inspected for each regression analysis output, controlling for the assumptions of normality, linearity, homoscedasticity and independence of residuals, in addition to checking for extreme outliers (Pallant, 2013). This visual inspection indicated no major violations of the assumptions. The potential impact of outliers was also explored by comparing the mean to the 5% trimmed mean for each variable, where the top and bottom 5% cases are excluded before calculating a new mean. The 5% trimmed mean was very similar to the total mean for all variables, indicating that outliers did not have a strong impact on the mean values. Multicollinearity was not suspected from the correlations between independent

variables. Still, tolerance and VIF values were checked for all variables in the regression models, with no values indicating problems with multicollinearity (Tolerance < .10, VIF > 10) (Pallant, 2013).

The theoretical assumptions underlying hierarchical multiple regression are not met when the predictor variables are not normally distributed (Pallant, 2013). Parametric statistical tests are often applied regardless of these common violations of theoretical assumptions (Norman, 2010). Pearson's r has been found to be quite insensitive to extreme violations of normality (Havlicek & Peterson, 1977), and Norman (2010) argues that regression analysis can be utilized without concern about normally distributed variables. However, the bootstrap resampling method can be utilized as an internal replication mechanism, discovering potential distortions of results that can come from violated theoretical assumptions (Roberts & Fan, 2004).

2.4.4 Analytical Plan

A series of hierarchical multiple regression analyses were conducted to test the hypotheses. The choice of investigating each potential moderator separately was made to reduce the chance of false negatives (type II error), based on the sample size and the expected low effect sizes (Faul et al., 2009). The predictors were entered in three steps as illustrated in table 2.1. The first step was identical in each analysis, establishing whether variance in concurrent maternal depressive symptoms could explain some of the variance in child internalizing and externalizing problems. Then one of the potential moderators was entered in step two to control for its individual contribution to the model. The third step was where the test of moderation occurred, when entering the interaction term between concurrent maternal depressive symptoms and the relevant potential moderator variable. The outcome variables internalizing and externalizing problems were investigated separately, giving two models for each potential moderator. Each regression analysis was conducted using the bootstrap resampling method to control for the stability and replicability of results (Thompson, 1995). This entails that each analysis was replicated for 1,000 randomly selected samples pulled with replacement from the original sample (Roberts & Fan, 2004). The mean standard error and significance tests for these 1,000 analyses were compared to the results from the original sample as an indicator of stability and replicability of results. All analyses were conducted using version 24 of IBM SPSS Statistics. Only significant moderator-models of the original

sample are presented in tables below, for non-significant models and bootstrapping results, see the appendix.

Table 2.1 *Order of Entry for Hierarchical Multiple Regression Analyses*

Step 1	Maternal depressive symptoms (BDI-II)
Step 2	Potential moderator (Gender / Temperament dimension / Inhibitory control)
Step 3	Interaction term (BDI-II x moderator)

3 Results

3.1 Variable Description

3.1.1 Measurement Outcomes

The outcomes for individual measures are listed in table 3.1. For concurrent maternal depressive symptoms, 10.4% of the sample reported no depressive symptoms, and 13.5% had scores above the cut-off indicating mild depression. For the CBCL, 9.4% of the children had T scores above the cut-off for borderline clinical scores (T>65) for at least one of the problem scales. As seen from table 3.1, the mean T-scores for internalizing and externalizing problems are lower in this sample than in the normative sample (M=50). The mean score on the Flanker task indicates a ceiling effect, meaning that the task was easier than intended. 71.4% of the participants had 90-100% correct responses on the incongruent trials. For the temperament dimensions, the means and standard deviations are comparable to what is reported by Mathiesen and Tambs (1999). Their reported standard deviations are somewhat lower (0.5-0.6) compared to the present sample, which is expected as the short form used in the present study has less internal consistency.

Table 3.1 *Measurement outcomes*

	N	Mean	Standard Deviation	Range
Current Maternal Depressive Symptoms (BDI-II)	96	7.9	7.8	0 - 37
Child Internalizing problems (CBCL)	96	48.0	11.1	29 - 71
Child Externalizing Problems (CBCL)	96	46.5	12.1	28 - 85
Inhibitory Control (Flanker Task)	91	0.90	0.12	0.3 - 1.0
Emotionality (EAS)	81	2.8	0.8	1.0 - 5.0
Activity (EAS)	81	3.7	0.7	2.3 - 5.0
Sociability (EAS)	81	3.7	0.7	2.3 – 5.0
Shyness (EAS)	81	2.1	0.7	1.0 - 4.0

3.1.2 Bivariate Correlations

Bivariate correlations between the variables are presented in table 3.2. The two outcome variables, internalizing and externalizing problems, are highly correlated, as expected. The predictor variable concurrent maternal depressive symptoms (BDI-II) is significantly

correlated with both outcome variables. Of the potential moderators, only temperamental emotionality is significantly correlated with the outcome variables. The variables may still have a moderating effect on the association between concurrent maternal depressive symptoms and child internalizing or externalizing problems without having a direct correlation with the outcome (Taylor, 2013). Thus, no variables are excluded from analysis based on the correlation matrix.

The measure of child inhibitory control is negatively correlated with temperamental activity and sociability, while positively correlated with shyness. This means that children who are more active and socially oriented, struggle more with inhibitory control, while children who are more shy have better inhibitory control. This fits well with the theoretically expected directions of associations, supporting the validity of the constructs and reliability of the measurements. The relatively low correlations also serve to support the notion that inhibitory control is something different than temperament. The direction of the significant correlations between the temperament dimensions are also in line with theory and the factor analysis by Mathiesen and Tambs (1999).

Table 3.2 *Bivariate correlations*

		1	2	3	4	5	6	7	8	9
1	**Child Internalizing Problems**	1								
2	**Child Externalizing Problems**	.71**	1							
3	**Concurrent Maternal Depressive Symptoms**	.42**	.38**	1						
4	**Child Gender**	.14	.04	.02	1					
5	**Child Temperamental Emotionality**	.32**	.24*	.23*	.06	1				
6	**Child Temperamental Activity**	-.01	.21	.03	.00	.18	1			
7	**Child Temperamental Sociability**	-.15	.02	-.15	.14	.13	.37**	1		
8	**Child Temperamental Shyness**	.27	-.06	-.01	.12	.06	-.17	-.34**	1	
9	**Child Inhibitory Control**	.07	-.13	-.03	-.02	.03	-.39**	-.38**	.30**	1

** Correlation is significant at the 0.01 level (two-tailed)
* Correlation is significant at the 0.05 level (two-tailed)

3.2 Hierarchical Multiple Regression Analysis

3.2.1 Maternal Depressive Symptoms as a Predictor

First, using internalizing problems as the dependent variable, concurrent maternal depressive symptoms (BDI-II) was entered in step one, explaining 17.6% of the variance in internalizing problems (F (1, 94) = 20.12, $p < .001$). With externalizing problems as the dependent variable, maternal depressive symptoms as a predictor gave a model explaining 14.7% of the variance in outcome (F (1, 94) = 16.21, $p < .001$). Hence, BDI-II is found to be a statistically significant predictor, meaning that variance in concurrent maternal depressive symptoms explains a portion of the variance in both child internalizing and externalizing problems, supporting the first hypothesis. The results were compared to the mean standard errors and p-values of the 1,000 generated samples from the bootstrap resampling method. The differences were negligible, suggesting that the results are robust and replicable across samples (see appendix B, table 6.2). Including maternal depressive symptoms in each model's first step is a prerequisite for testing potential moderators of this association in the next steps.

3.2.2 Gender Moderation Analysis

After controlling for concurrent maternal depressive symptoms in step one, adding gender in step two did not contribute to any statistically significant increase in either model's explained variance. Hence, gender cannot explain variance in child internalizing or externalizing problems when controlling for the effects of concurrent maternal depressive symptoms. The interaction term (BDI-II x gender) did not add statistically significant contributions to the model when entered in step three, meaning that gender does not moderate the association between concurrent maternal depressive symptoms and child internalizing or externalizing problems in the present sample (see appendix A, tables 5.1 and 5.2).

3.2.3 Temperament Moderation Analysis

Testing for moderation effects of each of the four temperament dimensions, concurrent maternal depressive symptoms was still entered in step one. The model's explained variance significantly increased for internalizing, but not externalizing problems, when adding emotionality in step two. The regression analysis is presented in table 3.3. The explained variance increased by 5.4% when adding emotionality, giving a model explaining 23% of variance in internalizing problems (F (2, 78) = 11.66, $p < .001$). This means that variance in child emotionality can explain some of the variance in child internalizing problems when

controlling for the effects of concurrent maternal depressive symptoms. The main effect was replicated by the bootstrap resampling method, indicating that this is a stable result (see appendix B, table 6.1). The interaction term (BDI-II x child emotionality) did not add statistically significant contributions to either model when entered in step three. None of the other temperament dimensions (activity, shyness and sociability) or their interaction terms added any statistically significant contributions to either model. When externalizing problems was the outcome, adding activity in step two was close to giving a statistically significant contribution to the model (p =.062), indicating that this temperament dimension may have the potential to explain some of the variance in externalizing problems in a larger sample. The non-significant interaction terms mean that no temperament dimension was found to moderate the association between maternal depression and child internalizing or externalizing problems (see appendix A, tables 5.3-5.9).

Table 3.3 *Summary of hierarchical regression analysis testing for moderation effects of emotionality when predicting child internalizing problems.*

	Model 1			**Model 2**			**Model 3**		
Variable	**B**	**SE B**	**β**	**B**	**SE B**	**β**	**B**	**SE B**	**β**
Maternal Depression	.60	.15	.42**	.52	.15	.37**	.55	.15	.38**
Emotionality				3.30	1.41	.24*	3.17	1.41	.23*
Maternal depression x Emotionality							-1.73	1.20	-.14
R^2		.176			.230			.251	
F for change in R^2		16.91**			5.47*			2.09	

** p < 0.01 * p < 0.05

3.2.4 Inhibitory Control Moderation Analysis

Again, concurrent maternal depressive symptoms was entered in the first step of the hierarchical multiple regression analysis. Adding the inhibitory control measure in step two did not significantly increase either model's explained variance. This means that variance in child inhibitory control cannot explain variance in child internalizing or externalizing problems when controlling for the effects of concurrent maternal depressive symptoms. Adding the interaction term in step three (BDI-II x inhibitory control) significantly increased

explained variance in both models. In the first model, presented in table 3.4, the interaction term increased explained variance by 4.8%, giving a model which as a whole explains 23.1% of the variance in internalizing problems (F (3, 87) = 8.69, p < .001). In this model, the main effect of inhibitory control becomes statistically significant. Thus, adding the interaction term in step three, may have revealed an independent effect of inhibitory control on internalizing problems which was hidden in step two. Main effects are often not meaningful in the presence of interaction effects, but this needs further exploration.

Table 3.4 *Summary of hierarchical regression analysis testing for moderation effects of child inhibitory control when predicting child internalizing problems.*

	Model 1			**Model 2**			**Model 3**		
Variable	**B**	**SE B**	**β**	**B**	**SE B**	**β**	**B**	**SE B**	**β**
Maternal Depression	.60	.14	.42**	.60	.14	.42**	.60	.13	.42**
Inhibitory Control				7.51	9.16	.08	33.48	14.28	.35*
Maternal depression x Inhibitory Control							-.28	.12	-.35*
R^2		.176			.183			.231	
F for change in R^2		19.05**			.67			5,43*	

** p < 0.01 * p < 0.05

Table 3.5 *Summary of hierarchical regression analysis testing for moderation effects of child inhibitory control when predicting child externalizing problems.*

	Model 1			**Model 2**			**Model 3**		
Variable	**B**	**SE B**	**β**	**B**	**SE B**	**β**	**B**	**SE B**	**β**
Maternal Depression	.60	.15	.38**	.59	.15	.38**	.59	.15	.38**
Inhibitory Control				-12.65	10.13	-.12	21.20	15.62	.20
Maternal depression x Inhibitory Control							-.36	.13	-.42**
R^2		.147			.162			.230	
F for change in R^2		15.35**			1.56			7.72**	

** p < 0.01 * p < 0.05

For the model with externalizing problems as the dependent variable, adding the interaction term increased explained variance by 6.8%, giving a model explaining 23% of the variance in externalizing problems (F (3, 87) = 8.67, p < .001). This regression analysis is presented in table 3.5. Thus, child inhibitory control is found to moderate the association between concurrent maternal depressive symptoms and both child internalizing and externalizing problems. The significant moderation models were replicated by the bootstrap resampling method. Standard errors and p-values were highly similar, indicating that the results are stable and replicable across samples (see appendix B, tables 6.2 and 6.3).

To further explore this moderation, a schematic representation approach is recommended for interactions between continuous variables (Aiken & West, 1991). Both variables of maternal depressive symptoms and child inhibitory control were dichotomized by a median split, giving (2x2) four combinations of the independent variables. In turn, the mean T-scores for both internalizing and externalizing problems were found for each of the four groups, and plotted as can be seen in figures 3.1 and 3.2. The figures show that the association between maternal depressive symptoms and each of internalizing and externalizing problems is stronger when inhibitory control is low. Causality cannot be determined from this correlational, cross-sectional study. However, the results are in line with the hypothesis that

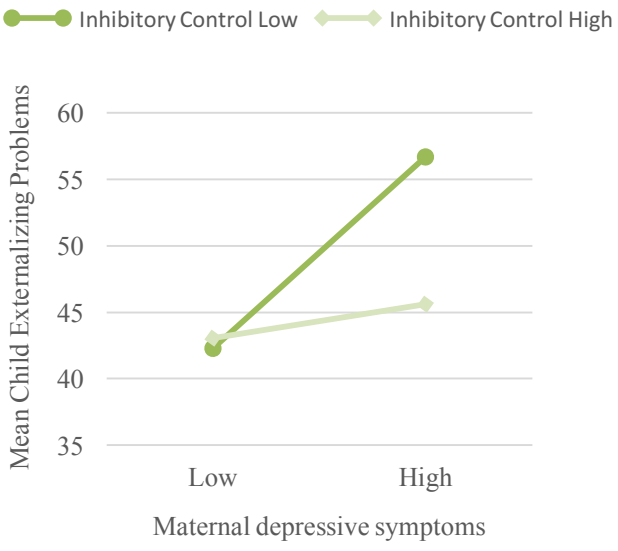

Figure 3.1 *Child inhibitory control as a moderator of the association between maternal depressive symptoms and child* ***externalizing*** *problems.*

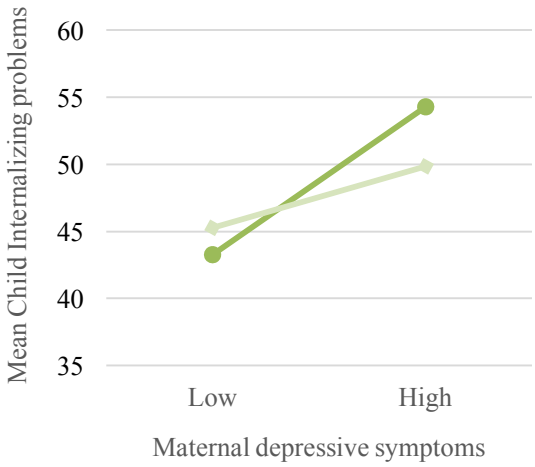

Figure 3.2 *Child inhibitory control as a moderator of the association between maternal depressive symptoms and child* ***internalizing*** *problems.*

children with lower inhibitory control are more vulnerable to the negative effects of concurrent maternal depressive symptoms. The graphs also illustrate that the apparent main effect of inhibitory control predicting child internalizing problems in this model is not meaningful to interpret. The participants with high inhibitory control do not generally have higher levels of internalizing problems regardless of maternal depressive symptoms.

4 Discussion

4.1 Findings

The present study found the expected main effect of concurrent maternal depressive symptoms predicting both child internalizing and externalizing problems. The associations were positive, so that higher levels of maternal depressive symptoms corresponded with higher levels of child problems. This finding is in line with previous research (Goodman et al., 2011). In addition, a main effect of temperamental emotionality was found to predict internalizing problems when controlling for maternal depressive symptoms. This was not included in the study's hypotheses, but in line with previous research finding temperamental emotionality to be associated with depression in both children (Dougherty, Klein, Durbin, Hayden, & Olino, 2010) and adults (Elovainio et al., 2015).

Investigating moderation, there appeared to be no moderating effect of child gender or temperament. However, an interaction effect between child inhibitory control and maternal depressive symptoms was found for both child outcomes. Children with lower inhibitory control showed a stronger association between maternal depressive symptoms and both internalizing and externalizing problems. This supports the hypothesis that children with low inhibitory control are more vulnerable to the negative effects of maternal depression (c.f. Flouri et al., 2016). Still, since the study is cross-sectional, causation cannot be determined. The results may also be caused by the development of inhibitory control being negatively affected by exposure to higher levels of maternal depressive symptoms. The results for each investigated child characteristic will be discussed below before methodological considerations and the study's implications for clinical practice and research follow.

4.1.1 Gender

No moderation effect of child gender was found in this study. This may be due to gender truly not moderating the association between maternal depression and child internalizing or externalizing problems, in which case sustaining the null-hypothesis is correct. However, this finding diverges from some of the previous studies assessing this association. The meta-analysis by Goodman et al. (2011) did not find gender to moderate the association between maternal depression and child externalizing problems. Nevertheless, they found a moderator effect for the association between maternal depression and child internalizing problems,

where the association was stronger for girls compared to boys, independent of age (Goodman et al., 2011). The other reviewed studies finding moderation effects of gender are either longitudinal and more sensitive to timing of maternal depression (Blatt-Eisengart et al., 2009; Choe et al., 2013) or investigating younger (Beeghly et al., 2017) or older children (Quarini et al., 2016) than in the present sample. This indicated age-dependent moderation may be caused by girls and boys varying in vulnerability to the negative effects of concurrent maternal depression throughout development. In addition, it is possible that different genetic vulnerability is inherited by girls and boys from their depression-prone mothers, and these vulnerabilities may be more prominent at different points in development. The environment may react systematically different to boys and girls, hence exposing them to different stressors interacting with their vulnerability at different times during development.

For the present thesis, the main focus has been directed to *concurrent* maternal depression. A related line of research has found gender moderation on very specific effects of timing of *prenatal* depression exposure. Maternal anxiety and depressive symptoms during the first trimester had a significant effect on boys' internalizing and total problems, whereas for girls, only exposure in the third trimester had a significant effect on internalizing and externalizing problems (de Bruijn, van Bakel, & van Baar, 2009). The authors hypothesize that testosterone may mediate an effect of heightened cortisol levels caused by maternal emotional problems. Male fetuses have the highest levels of testosterone between gestational week 10 and 20, while female fetuses' level of testosterone increase over time (de Bruijn, van Bakel, & van Baar, 2009). The same research group also investigated cortisol levels of preschool children who had or had not been exposed to prenatal emotional complaints, controlling for gender differences (de Bruijn, van Bakel, Wijnen, Pop, & van Baar, 2009). They found that the prenatally exposed girls showed higher levels of cortisol than the non-exposed girls at preschool age, a difference which was not found between exposed and non-exposed boys (de Bruijn, van Bakel, Wijnen, et al., 2009). The prenatally exposed girls also showed higher levels of cortisol compared to prenatally exposed boys (de Bruijn, van Bakel, Wijnen, et al., 2009). Higher levels of cortisol is an indicator of altered HPA-axis functioning, and associated mental health problems (Khoury et al., 2016).

This cross-sectional study may not have found a moderation effect of gender because it lacks control of the timing and course of maternal depressive symptoms. The sample size did not allow to statistically control for prenatal depression exposure. This compounding of different

trajectories of maternal depression could potentially be hiding differences in vulnerability between the genders. Also, the gender differences may be less prominent in the age group studied, compared to younger and older children. In addition, despite the broad outcome measures of internalizing and externalizing problems being advised (Achenbach et al., 2016), more specific outcome measures such as clinical diagnosis or cortisol levels may have revealed gender differences.

4.1.2 Temperament

It was hypothesized that child temperamental emotionality would moderate the association between concurrent maternal depressive symptoms and child internalizing and externalizing problems. Whether the association would be stronger for high or low scorers was not specified because of contradicting evidence (c.f. Gartstein & Bateman, 2008; Jessee et al., 2012). Even though this moderating effect of emotionality was not found, higher levels of emotionality predicted higher levels of internalizing problems when controlling for the effects of concurrent maternal depressive symptoms. This main effect of temperamental emotionality corresponds well with previous research (c.f. Dougherty et al., 2010).

Regarding temperamental activity, and in line with the research of Jessee et al. (2012), it was hypothesized that children with higher ratings on this measure would show a stronger association between concurrent maternal depressive symptoms and both internalizing and externalizing problems. This hypothesis was not supported. A main effect of temperamental activity was close to reaching statistical significance when predicting child externalizing problems and controlling for the effects of maternal depressive symptoms. Even though a non-significant result cannot be interpreted, it gives reason to suspect that a larger sample size could give a significant main effect of temperamental activity.

No moderation effects were found for temperamental shyness or sociability, which was contrary to prediction. However, it should be noted that these hypotheses were less empirically founded. No evident gold standard exists regarding which temperament model to use or temperament dimensions to include when investigating these associations, but emotionality/self-regulation and surgency/activity have gotten the most attention in literature. Many researchers only investigate one or two temperament dimensions in relation to psychopathology (Tackett, 2006). Seeing the need for a more unified conceptualization of

temperament, De Pauw and Mervielde (2010) proposed to combine the taxonomies of temperament and personality into the Five Factor Model comprising of Neuroticism (N), Extraversion (E), Consciousness (C), Agreeableness (A) and Openness to Experience (O). Translating the most relevant domains into the more typical temperament terms, N concerns negative affect and emotionality, E concerns surgency and activity level and C concerns disinhibition and effortful control (De Pauw & Mervielde, 2010). They find in their review using this model that high N, especially, but also low E and C are associated with internalizing problems, while externalizing problems are associated with low C and A, in addition to high E and high or low N (De Pauw & Mervielde, 2010). This unified model is a theoretical proposition, and further research is needed to develop it (De Pauw & Mervielde, 2010). Still, the review points to the relevance of including more than one temperament dimension in investigating associations with psychopathology.

4.1.3 Inhibitory Control

Child inhibitory control was found to be a moderator of the association between maternal depressive symptoms and child problems. The analysis revealed that lower inhibitory control predicted a stronger association between concurrent maternal depressive symptoms and both child internalizing and externalizing problems, as illustrated in figures 4.1 and 4.2. This is in line with the theoretical model by Goodman and Gotlib (1999), positing higher intellectual and social-cognitive skills to be protective child characteristics (see figure 1.1). High inhibitory control seems to protect children from the negative effects of maternal depressive symptoms (see figure 3.1). Low inhibitory control, on the other hand, seems to contribute considerably to the development of externalizing problems when levels of maternal depressive symptoms are high. The same trend was observed for internalizing problems, where maternal depressive symptoms only seem to affect the children with low inhibitory control (see figure 3.2).

These findings are striking considering the earlier work from this project, and underline the importance of investigating beyond main effects models. Originally, the participants in this study were recruited in three different groups for the doctoral project of Hermansen (2016), based on whether the mothers reported depressive symptoms or antidepressant medication during pregnancy. Between-groups comparisons of reaction times and accuracy on the Flanker task did not reveal any statistically significant differences (Hermansen, Yrttiaho,

Roysamb, & Melinder, 2017). Hence, prenatal exposure to depression or antidepressant medication (SSRIs, Selective Serotonin Reuptake Inhibitors) did not seem to negatively affect the inhibitory control of preschool children. In the present study, child inhibitory control is not found to be significantly correlated with *concurrent* maternal depressive symptoms either (see table 3.2). In addition, child inhibitory control is not correlated with the outcome variables of internalizing or externalizing problems. Thus, the relevance of child inhibitory control is only evident when going beyond the main effects, investigating how it interacts with maternal depressive symptoms to predict child behavior problems.

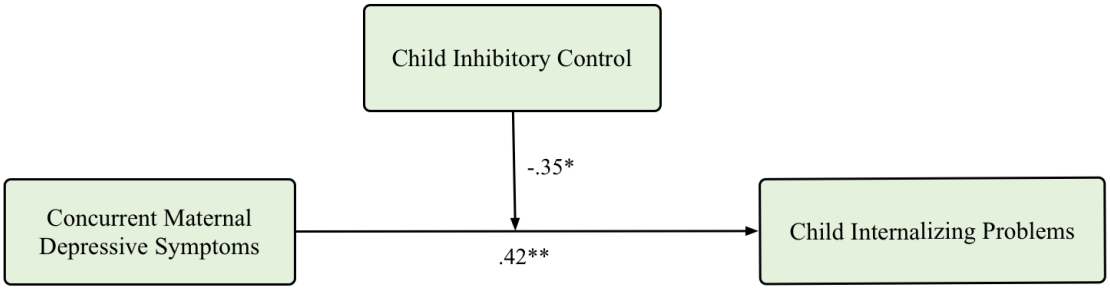

Figure 4.1 *Standardized regression coefficients (β) for the association between concurrent maternal depressive symptoms and child internalizing problems as moderated by child inhibitory control. (*p<.05)*

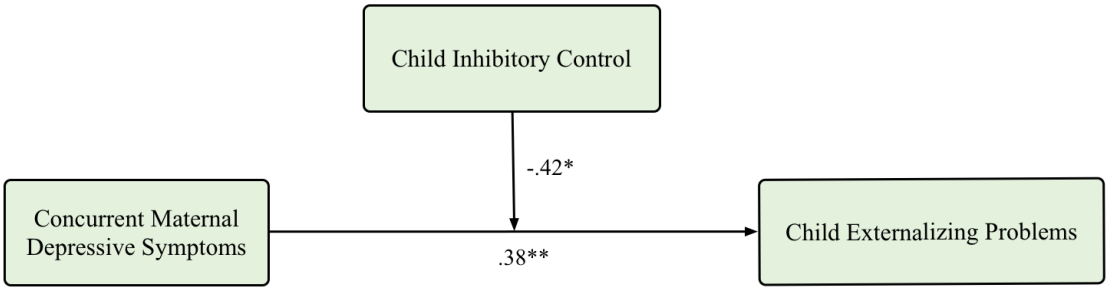

Figure 4.2 *Standardized regression coefficients (β) for the association between concurrent maternal depressive symptoms and child externalizing problems as moderated by child inhibitory control. (*p<.05)*

Thorough literature searches have not been successful in identifying previous studies investigating child inhibitory control as a moderator of the association between maternal depression and child behavior problems. However, the moderation effect of working memory found by Flouri et al. (2016) goes in the same direction as the moderation by inhibitory control in the present study. Thus, these are two of the three core executive functions (Miyake et al., 2000), moderating the association between maternal depressive symptoms and child internalizing and externalizing problems in the same way. Hughes (2011) reported that

maternal depression and executive functioning are negatively correlated in preschool children, while this association is absent when investigating older children or adolescents. As discussed above, this correlation is not found in the present sample. However, it would be interesting to investigate whether the moderating effects of inhibitory control and working memory found in young children continue into adolescence. As Tillman et al. (2015) found executive impairment to be most prominent in concurrently developing components of executive functions, the later developing components such as cognitive flexibility may be more relevant when investigating these associations in older children and adolescents.

If child executive functions are established through further research as a moderator of the association between maternal depression and negative child outcomes, an interesting new research question would be if training executive functions could reduce problems in children of depressed mothers. The possibility to train working memory and other executive functions in children is already supported in randomized, controlled trials (Klingberg et al., 2005). Still, generalizability of these improved abilities is controversial, and many studies are criticized for using outcome tests that are very similar to the training tasks (Shipstead, Redick, & Engle, 2010). Also, there are indications that inhibition is harder to train compared to working memory (Thorell, Lindqvist, Bergman Nutley, Bohlin, & Klingberg, 2009). A promising line of research uses a preschool program (Tools of the Mind) to improve executive functions, cost-effectively enhancing skills immediately relevant for academic achievements (Diamond et al., 2007). This may serve to be a supplement in helping these children, while the main focus of prevention and recovery should be on strengthening the social environment and treating maternal depression (Goodman & Garber, 2017).

4.2 Methodological Considerations

4.2.1 Sample

Two thirds of the mothers in the present sample were recruited for the doctoral project based on reports of depressive symptoms during pregnancy. Knowing the high recurrence rates of depression, it was expected that this sample would have higher levels of depressive symptoms compared to the general population. Categorizing the participants based on BDI-II norms for mild, moderate and severe depression, the sample has a somewhat higher prevalence of moderate depression (8.2% vs. 6.0%) compared to a Norwegian population study using BDI-II (N=875) (Siqveland & Kornør, 2011). However, prevalence of mild

depression was found to be lower in the present sample (4.2% vs. 10.6%), while the prevalence of severe depression was comparable (3.1% vs 2.4%) (Siqveland & Kornør, 2011). The size of the present sample (N=96) means the percentages roughly represent one participant each, making these small percentages very sensitive to measurement error. The prevalence of depression in this study was not higher than in the general population. Still, several studies have found sub-clinical levels of maternal depressive symptoms to be relevant for child development (Goodman et al., 2011), and this study also finds a strong association between maternal depressive symptoms and child internalizing and externalizing problems.

Longitudinal prospective cohort-studies such as MoBa are found to be vulnerable to self-selection bias (Nilsen et al., 2009). Women participating in the present study have not only given their consent to participate in the extensive MoBa study from pregnancy, but also opted to partake in this additional assessment six years later. Furthermore, the sample is quite homogenous in having high socio-economic status (Hermansen, 2016), presenting a potential buffering effect against negative influences of maternal depression. Hence, the depressed mothers who find the time and energy to do this may not be representative of the typically depressed mother. However, as studies of associations between variables are less sensitive to self-selection bias than studies of prevalence (Nilsen et al., 2009), this may not be a major issue of the present study.

Even though an association was found between maternal depressive symptoms and child internalizing and externalizing problems, most children (90.6%) had scores within the range considered normal. On the one hand, this result is optimistic, as the maternal depressive symptoms have not led to high levels of child problems. On the other hand, knowing the relatively low level of depressive symptoms and high socio-economic status of the sample, this may only serve to show that the sample is not representative of the general population. As the association still predicts that higher levels of child internalizing and externalizing problems are expected for higher levels of maternal depression, this suggests little buffering from being a sample with high socio-economic status. Although, a restricted range of scores implies carefulness regarding generalizability, and associations may be qualitatively different in children with severe behavior problems.

The present sample is also quite limited in size. Calculations based on expected low effect sizes indicated that 88 participants should be sufficient for it to be 95% chance to find effects

with a model with three predictor variables (Faul et al., 2009). Because of missing data, the moderation analysis of the temperament dimensions only included N=81. The near-significant main effect of activity in predicting child externalizing problems may have been found statistically significant in a larger sample. Still, the interaction terms for the temperament dimensions and maternal depression were far from reaching statistical significance. This indicates that if a true moderation effect of temperament was hidden in this study, there are probably other reasons than sample size.

4.2.2 Measurement

The present study utilized the computerized Flanker task for measuring child inhibitory control. It is noteworthy that this laboratory measure, independent of maternal response, was the one measure were moderation effects were found. The findings were replicated by bootstrapping, and appeared despite the distribution of scores being limited by a ceiling effect. Thus, this measurement is a strength of the present study, and the findings appear to be robust.

With the exception of the Flanker-task, this study mainly relies on questionnaire data from a single respondent, namely the mother. Several issues arise from this method of measurement and sole respondent. First, self-report measures of depression are criticized for being less valid than clinical diagnosis (Goodman & Gotlib, 1999). Self-report measures of depression include items asking about symptoms also relevant for other diagnosis, for instance anxiety (Carter et al., 2001). Hence, high symptom scores may represent general distress or general psychopathology, not clinical depression (Goodman & Tully, 2006). As mentioned in the introduction, depression is highly comorbid, and not controlling for other psychopathology may overestimate the effects of depression. However, comorbidity is found to be highly related to severity of depression (Kessler, Chiu, Demler, & Walters, 2005), which may imply that this is not a great concern in the present study. Goodman and Gotlib (1999) criticize the use of self-report instead of clinical diagnosis when studying maternal depression. As a result of their later meta-analysis, however, Goodman et al. (2011) convey less concern about how maternal depression is measured, as effect sizes were not found to be significantly larger when maternal depression was determined by clinical diagnosis.

Second, there are some concerns regarding the ability of the depressed mother to give accurate reports about their child. The distortion model posits that depressive symptoms may alter the mothers' view of their child, making their assessment less valid (Müller, Achtergarde, & Furniss, 2011). Maternal psychopathology has been found to be associated with true elevations in child psychopathology, and the accuracy model posits that reports by depressed mothers only reflects this (Müller et al., 2011). Friedlander, Weiss, and Traylor (1986) concluded that CBCL reported by depressed mothers are valid, as they found them to still separate children with and without clinical scores after controlling for the effects of maternal depression. Another study comparing depressed and non-depressed mothers found significant correlations between maternal depression scores and both maternal temperament reports and observational data using the Bayley scales, suggesting that the association was not just due to biased reporting by the mother (Whiffen & Gotlib, 1989). Treutler and Epkins (2003) found maternal psychopathology to be related to discrepancy between maternal report and child self-report of internalizing problems, but not externalizing. Setting the accuracy model up against the distortion model, Müller et al. (2011) found the distortion model to better fit the data. Caregiver depressive symptoms have previously been found to be one of the most important predictors of cross-informant disagreement (Müller et al., 2011).

Both parental internalizing symptoms and personality have been found to affect their temperament reports (Clark, Durbin, Donnellan, & Neppl, 2017). There is also evidence that parental perceptions of infant temperament may in fact shape the development of infant characteristics accordingly (Pauli-Pott, Mertesacker, Bade, Haverkock, & Beckmann, 2003). Parent report is widely used for measuring temperament, especially in larger samples (Bould et al., 2013). Standardized observational measures are often considered the gold standard, but this method is limited by the narrow observational time and possibly frightening laboratory setting (Bould et al., 2013). Parents may know their children best and see them across many situations, giving them a superior observer position (Jessee et al., 2012). Still, it can be argued that parents don't have enough knowledge about other children to be able to compare their own children to the norm (Jessee et al., 2012). Hence, reports by several informants are recommended, but Duhig, Renk, Epstein, and Phares (2000) conclude that one parent's report will be sufficient when including several informants is not feasible.

In the analyses using only maternal reports of both predictor and outcome, the associations between variables may be due to differences in response style between the mothers (i.e. the

same mothers tending to report more problems in general). Hence, there is reason to concern for a spurious relation between maternal depressive symptoms and child internalizing and externalizing problems. In their meta-analysis, Goodman et al. (2011) found significantly larger effect sizes for studies that relied on maternal report of child symptoms, compared to child self-report, a combination of these, or teacher-report. Still, this association has been replicated many times in studies with different methods of measurement, supporting that there is a true association (Goodman et al., 2011). Regarding temperament assessment in this study, maternal report was two years prior to the other measures, which lowers the probability of these spurious associations.

4.2.3 Study Design

The principles of *multifinality* (same predictor, different outcomes) and *equifinality* (different predictors, same outcome) emphasize the complexity of modeling child development (Sameroff, 2009). Employing a cross-sectional and correlational design, the present study only investigated a small part of the model by Goodman and Gotlib (1999). Considering children as active participants in their own development, longitudinal studies with larger samples are necessary to model this complexity more accurately. Still, preliminary research identifying individual moderation effects contribute by informing the development of larger models.

With a fairly limited sample size, the present study was not able to control for several known confounding variables, such as previous depressive episodes, socio-economic status and paternal presence and psychological health. The correlation between prenatal and concurrent depressive symptoms in this sample was too high for it to be statistically meaningful to include both in a model with this sample size. Regarding the father, this data set does not include information on his psychological health or presence. Socio-economic status in this sample is generally high, but somewhat lower in the original groups of mothers who were reporting depressive symptoms during pregnancy compared to the control group (Hermansen, 2016).

With regards to the analytical choice of running several separate hierarchical multiple regression analyses, this was made to avoid type II errors, incorrectly sustaining the null-hypothesis. This choice simultaneously increases the risk for type I errors, incorrectly

discarding the null-hypothesis (Banerjee, Chitnis, Jadhav, Bhawalkar, & Chaudhury, 2009). The study comprised (6x2) twelve hierarchical regression analyses in total. With a significance level of $p<.05$, one in twenty (five percent) of the results can be expected to reach statistical significance by chance. Ideally, one would like to minimize the chance of any error, but statistical tests always include this trade-off between errors (Banerjee et al., 2009). In this study, incorrectly claiming that an association is true (type I error) is not considered to have very harmful consequences. Knowledge in the field of psychology is based on accumulated results from many studies regarding the same associations. Thus, the risk of type I errors is accepted to decrease the likelihood of missing a true association. The moderation analysis was only significant for one of the tested moderators in this study, inhibitory control. However, the same moderator was found to be significant for the associations with both outcome variables, indicating that the effects were not random. In addition, the bootstrap resampling method was employed as a control measure, considerably increasing the likelihood that the results did not appear by chance.

4.3 Implications

4.3.1 Clinical Implications

Despite the methodological considerations discussed above, the findings of the present study have some clinical implications. First, the results support that even sub-clinical maternal depressive symptoms may increase the risk of negative child development in preschool age. The relevance of maternal depressive symptoms also after the first year after birth is supported. Hence, depression screening of mothers caring for young children can serve to identify a vulnerable group that can profit from preventive measures. The present study did not investigate the possible mediators this risk may be transferred through. However, previous studies find positive effects of programs aimed at enhancing parenting skills (Goodman & Garber, 2017) and psychotherapy aimed at the parent to reduce child symptoms (Cuijpers et al., 2015).

Secondly, the finding that children with low inhibitory control show a stronger association between maternal depressive symptoms and internalizing and externalizing problems, more specifically identifies a group of greater risk. Mental health professionals should be especially sensitive to the mental health status of parents of referred children that shows signs of diminished executive functioning. However, a great proportion of referred children have

disorders implicating diminished executive functions, such as hyperkinetic- and conduct disorders. Implementing programs aimed at enhancing executive functions in a preschool or school setting may prove useful for this group (c.f. Diamond et al., 2007). Generally, this study further supports the relevance of mental health professionals being concerned with executive functioning of children.

4.3.2 Implications for Future Research

As the complex interactions in child development, and the notions of multifinality and equifinality imply, more complex models, sensitive to timing and course of parental and child symptoms, bidirectional associations and interactions between variables are needed to get the broader picture. Still, simpler studies of individual associations and interaction effects are the first step in developing the larger models (Goodman et al., 2011). The moderation effects uncovered in the present study are of great interest, but as always further assessments are warranted. Preferably in more diverse and larger samples, allowing to control for known confounding variables, such as family social-economic status and maternal history of depression. In addition, as the different components of executive functions gradually develop through childhood and adolescence, the association should be further explored through studies of older children, so that a broader set of child executive functions may be investigated.

As the methodological discussion above shows, the theoretically proposed moderation effects of child characteristics may still be relevant despite the lack of association in the present study. Moderation effects may only be revealed in more specific child outcome measures or when the age of the children are lower or higher than in the present study. Based on the literature reviewed in this thesis, study designs sensitive to timing of depression exposure are also expected to be more likely to find moderation effects.

4.4 Conclusion

The present study finds higher levels of concurrent maternal depressive symptoms to be associated with higher levels of child internalizing and externalizing problems in preschool children. Importantly, child inhibitory control is found to moderate the association so that children with lower inhibitory control show a stronger association between maternal depressive symptoms and internalizing and externalizing problems.

The child characteristics of temperament and gender was not found to moderate the association. Several limitations regarding the sample, measurements and design of this study are discussed, and future research regarding children of depressed mothers should be sensitive to possible moderation effects of child characteristics.

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Appendix A

Table 5.1 *Summary of hierarchical regression analysis testing for moderation effects of gender when predicting child internalizing problems (N=96).*

	Model 1			Model 2			Model 3		
Variable	**B**	**SE B**	**β**	**B**	**SE B**	**β**	**B**	**SE B**	**β**
Maternal Depression	.60	.13	.42**	.594	.13	.42**	.68	.18	.48**
Gender				2.83	2.06	.13	2.79	2.07	.13
Maternal depression x Gender							-1.50	2.09	-.09
R^2		.176			.193			.197	
F for change in R^2		20.12**			1.89			.52	

** p < 0.01 * p < 0.05

Table 5.2 *Summary of hierarchical regression analysis testing for moderation effects of gender when predicting child externalizing problems (N=96).*

	Model 1			Model 2			Model 3		
Variable	**B**	**SE B**	**β**	**B**	**SE B**	**β**	**B**	**SE B**	**β**
Maternal Depression	.60	.15	.38**	.60	.15	.38**	.59	.20	.38**
Gender				.81	2.31	.03	.82	2,33	.03
Maternal depression x Gender							.151	2,35	.01
R^2		.147			.148			.148	
F for change in R^2		16.21**			.12			.00	

** p < 0.01 * p < 0.05

Table 5.3 *Summary of hierarchical regression analysis testing for moderation effects of emotionality when predicting child externalizing problems (N=81).*

	Model 1			Model 2			Model 3		
Variable	**B**	**SE B**	**β**	**B**	**SE B**	**β**	**B**	**SE B**	**β**
Maternal Depression	.60	.16	.38**	.54	.16	.35**	.57	.16	.37**
Emotionality				2.47	1.60	.16	2.30	1.59	.15
Maternal depression x Emotionality							-2.24	1.35	-.17
R^2		.147			.172			.201	
F for change in R^2		13.62**			2.38			2.75	

** p < 0.01 * p < 0.05

Table 5.4 *Summary of hierarchical regression analysis testing for moderation effects of activity when predicting child internalizing problems (N=81).*

	Model 1			Model 2			Model 3		
Variable	**B**	**SE B**	**β**	**B**	**SE B**	**β**	**B**	**SE B**	**β**
Maternal Depression	.60	.15	.42**	.60	.15	.42**	.59	.15	.41**
Activity				-.37	1.60	-.02	-.47	1.61	-.30
Maternal depression x Activity							-.92	1.59	-.06
R^2		.176			.177			.180	
F for change in R^2		16.91**			.05			.34	

** p < 0.01 * p < 0.05

Table 5.5 *Summary of hierarchical regression analysis testing for moderation effects of activity when predicting child externalizing problems (N=81).*

	Model 1			Model 2			Model 3		
Variable	**B**	**SE B**	**β**	**B**	**SE B**	**β**	**B**	**SE B**	**β**
Maternal Depression	.60	.16	.38**	.59	.60	.38**	.58	.16	.37**
Activity				3.28	1.74	.19	3.23	1.76	.19
Maternal depression x Activity							-.54	1.73	-.03
R^2		.147			.184			.185	
F for change in R^2		13.62**			3.57			.10	

** p < 0.01 * p < 0.05

Table 5.6 *Summary of hierarchical regression analysis testing for moderation effects of sociability when predicting child internalizing problems (N=81).*

	Model 1			Model 2			Model 3		
Variable	**B**	**SE B**	**β**	**B**	**SE B**	**β**	**B**	**SE B**	**β**
Maternal Depression	.60	.15	.43**	.58	.15	.41**	.60	.16	.42**
Sociability				-1.47	1.66	-.09	-1.36	1,69	-.08
Maternal depression x Sociability							.61	1,28	.05
R^2		.176			.185			.187	
F for change in R^2		16.91**			.79			.24	

** p < 0.01 * p < 0.05

Table 5.7 *Summary of hierarchical regression analysis testing for moderation effects of sociability when predicting child externalizing problems (N=81).*

	Model 1			Model 2			Model 3		
Variable	**B**	**SE B**	**β**	**B**	**SE B**	**β**	**B**	**SE B**	**β**
Maternal Depression	.60	.16	.38**	.61	.16	.40**	.62	.18	.40**
Sociability				1.35	1.85	.08	1.38	1.88	.08
Maternal depression x Sociability							.17	1.43	.01
R^2		.147			.153			.153	
F for change in R^2		13.62**			.53			.01	

** p < 0.01 * p < 0.05

Table 5.8 *Summary of hierarchical regression analysis testing for moderation effects of shyness when predicting child internalizing problems (N=81).*

	Model 1			Model 2			Model 3		
Variable	**B**	**SE B**	**β**	**B**	**SE B**	**β**	**B**	**SE B**	**β**
Maternal Depression	.60	.15	.42**	.60	.15	.42**	.60	.15	.42**
Shyness				2.05	1.64	.13	2.05	1.64	.13
Maternal depression x Shyness							.00	1.29	.00
R^2		.176			.193			.193	
F for change in R^2		16.91**			1.57			.00	

** p < 0.01 * p < 0.05

Table 5.9 *Summary of hierarchical regression analysis testing for moderation effects of shyness when predicting child externalizing problems (N=81).*

	Model 1			Model 2			Model 3		
Variable	**B**	**SE B**	**β**	**B**	**SE B**	**β**	**B**	**SE B**	**β**
Maternal Depression	.60	.16	.38**	.60	.16	.38**	.60	.16	.38**
Shyness				-.90	1.84	-.05	.89	1.86	-.05
Maternal depression x Shyness							-.07	1.45	-.01
R^2		.147			.150			.150	
F for change in R^2		13.62**			.24			.00	

** p < 0.01 * p < 0.05

Appendix B

Table 6.1 *Mean standard errors and p-values derived by the bootstrap resampling method (1,000 samples) for the moderation model of emotionality when predicting child internalizing problems.*

	Original Sample			Bootstrap	
Variables	**B**	**SE B**	**Sig.**	**Mean SE B**	**Sig.**
Maternal Depression	.53	.15	.001	.16	.001
Emotionality	3.17	1.39	.026	1.60	.043
Maternal depression x Emotionality	-1.67	1.18	.163	1.33	.144

Table 6.2 *Mean standard errors and p-values derived by the bootstrap resampling method (1,000 samples) for the moderation model of inhibitory control when predicting child internalizing problems.*

	Original Sample			Bootstrap	
Variables	**B**	**SE B**	**Sig.**	**Mean SE B**	**Sig.**
Maternal Depression	.61	.13	.000	.14	.001
Inhibitory Control	34.02	14.41	.020	11.94	.001
Maternal depression x Inhibitory Control	-.28	.12	.021	.15	.012

Table 6.3 *Mean standard errors and p-values derived by the bootstrap resampling method (1,000 samples) for the moderation model of inhibitory control when predicting child externalizing problems.*

	Original Sample			Bootstrap	
Variables	**B**	**SE B**	**Sig.**	**Mean SE B**	**Sig.**
Maternal Depression	.58	.15	.000	.19	.003
Inhibitory Control	21.53	15.87	.178	16.22	.109
Maternal depression x Inhibitory Control	-.37	.13	.007	.23	.022