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Biological and Contextual Correlates of Cortisol Reactivity in Early Childhood

Katie R. Kryski, *The University of Western Ontario*

Supervisor: Dr. Elizabeth P. Hayden, *The University of Western Ontario*

A thesis submitted in partial fulfillment of the requirements for the Doctor of Philosophy degree in Psychology

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BIOLOGICAL AND CONTEXTUAL CORRELATES OF CORTISOL REACTIVITY IN
EARLY CHILDHOOD

(Thesis format: Monograph)

by

Katie Rose Kryski

Graduate Program in Clinical Psychology

A thesis submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy

The School of Graduate and Postdoctoral Studies
The University of Western Ontario
London, Ontario, Canada

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Abstract

Purpose: Individual differences in early-emerging vulnerability to mood and anxiety disorders have been linked to genetic and environmental influences, with psychophysiological reactivity potentially mediating this vulnerability. However, research seeking to identify influences on the development of psychophysiological reactivity, such as the Hypothalamic-Adrenal-Pituitary (HPA) axis, is still in an early stage, with most studies focusing on individual risks, even though such vulnerability is likely etiologically complex. Disentangling the interplay of biology and context in shaping HPA axis responses to stress, indexed via salivary cortisol reactivity, may ultimately aid in the development and application of targeted prevention and early intervention programs. **Method:** This study examined whether key biological and contextual variables, including specific genes (5-HTTLPR and BDNF val66met), parent psychopathology, poor parenting, and life stress, were related to cortisol reactivity to psychosocial stress in 409 preschool-aged children. Parenting was assessed using questionnaires and observational ratings, and stress and parent psychopathology were assessed using structured interviews. Cortisol reactivity was indexed using both area under the curve and multi-level modelling. **Results:** Maternal depression interacted with poor parenting and chronic stress to predict child cortisol reactivity. Specifically, evidence was found for dysregulated cortisol reactivity in children with a maternal depression history who were exposed to life stress, including hyperreactivity in the context of chronic stress and hyporeactivity in the context of poor parenting. In contrast, the cortisol reactivity of children with no maternal depression history was unrelated to these environmental influences. However, the pattern of findings differed depending on the index of cortisol reactivity being examined (AUC versus MLM). Paternal depression had a stronger influence on baseline or trait-like cortisol relative to cortisol reactivity. **Conclusion:** Findings

suggest that children with a history of maternal depression and exposure to early stress may be at the greatest risk for HPA dysregulation, and that this risk is manifested differently depending on which type of early stress is experienced. Findings highlight a potential mechanism, cortisol stress reactivity, through which familial depression risk and the early environment influence children's vulnerability. Results also speak to the importance of methodological factors when examining cortisol reactivity to stress.

Keywords

Cortisol; HPA axis; familial risk; parenting; life stress; 5-HTTLPR; BDNF; AUC; multi-level modeling

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Introduction

Depression is a serious and often incapacitating disorder. According to Health Canada, approximately 11% of men and 16% of women in Canada will experience major depressive disorder during their lifetimes (2002). Data from a Canadian community health survey indicated that over two million individuals in Canada aged 12 and older suffered from a mood disorder in 2011 (Statistics Canada, 2012), and depression costs the Canadian economy approximately \$14.4 billion every year (Office of the Auditor General of Canada, 2001). Speaking further to its impact, research indicates that the onset of depression may occur earlier than previously thought (Luby et al., 2003), potentially disrupting important developmental goals of adolescence and early adulthood. Most experts agree that depression is etiologically heterogeneous and likely rooted in both biological and environmental factors, highlighting the importance of research that attempts to capture this complexity by modeling multiple domains that likely influence emerging vulnerability. Such work would have implications for preventative and intervention strategies. Unfortunately, research on vulnerability to depression has traditionally progressed in a piecemeal manner, testing narrowly defined etiological theories, rather than incorporating a top-down strategy that accounts for the interactive effects of biological and contextual factors.

Work that seeks to identify markers of depression risk will benefit from an examination of mediators of early vulnerability; one such key mediator appears to be hypothalamic-pituitary-adrenal (HPA) axis dysregulation, a heritable and early-emerging risk factor for depression (Dougherty et al., 2009; Goodyer, Herbert, Tamplin, & Altman, 2000; Harris et al., 2000; Steptoe et al., 2009). HPA axis activity is often measured via its glucocorticoid end product, cortisol. The hormone cortisol is an attractive substance by which to gauge HPA reactivity, as it is readily accessible through saliva sampling (Inder,

Dimeski, & Russell, 2012), thereby providing a non-invasive means of indexing HPA reactivity. It is well known that activation of the HPA system following a stressor is an adaptive response (Selye, 1956); however, the trajectory of cortisol activity following a stressor may have important implications for adjustment, as the failure of the HPA system to successfully downregulate post-stressor leads to prolonged exposure to cortisol (Selye, 1974). Such prolonged exposure may have detrimental effects on brain tissue as well as on overall mental health, given that cortisol serves to suppress the immune system in order to divert resources to other functions more central to immediate survival, and also has neurodegenerative properties (de Felice et al., 2008; Gunnar & Talge, 2008; Pacak et al., 2002). HPA axis activity indexed via cortisol appears to be a marker of current disorder, often distinguishing individuals diagnosed with major depression, as well as some anxiety disorders, from those without these conditions (Barden, 2004; Risbrough & Stein, 2006; Shea Walsh, MacMillan, & Steiner, 2005). Further, recent research suggests that HPA *dysregulation* in general, rather than hyperreactivity alone, may be vulnerability marker of greater risk for depression (Guerry & Hastings, 2011; Lopez-Duran, Kovacs, & George, 2009). For example, depression risk indexed by subthreshold symptoms and familial risk has been associated with an attenuated or “blunted” HPA reactivity in studies examining the cortisol awakening response (Huber et al., 2006; Kuehner, Holzhauser, & Huffziger, 2007; Stetler & Miller, 2005) and psychosocial stress reactivity (Ayer et al., 2013; Harkness, Stewart, & Wynne-Edwards, 2011; Luby et al., 2003). Attenuation of HPA reactivity can result from chronic activation of the HPA system over time, related to desensitization of glucocorticoid receptors or damage to cortical regions (e.g., hippocampus) due to prolonged cortisol exposure (Kudielka & Wüst, 2010). Thus, high-risk children who exhibit cortisol HPA hyporeactivity to stress may be more susceptible to depression in part due to having an

unresponsive stress system, which may result in impairments in coping with stress (Hankin, Badanes, Abela, & Watamura, 2010). Taken together, this research suggests that dysregulation of the HPA system, in the form of either hyper- or hyporeactivity to stress, may be an important marker of psychopathology risk.

An emerging body of research (Gotlib, Joormann, Minor, Hallmayer, 2008; Kryski, Smith, Sheikh, Singh, & Hayden, 2013; Natsuaki et al., 2009) indicates that even young children's HPA axis responses to stress are relevant to their vulnerability to disorder, raising the question of which factors are most important to shaping this early risk. A better understanding of these factors would help build theory on the developmental psychopathology of depression and potentially guide preventative interventions. Given the complexity of the HPA axis system (Selye, 1974), it seems likely that many etiological factors are involved; while a large body of work on the role of biological and contextual variables in shaping physiological stress responses has emerged in recent decades, few studies have explored a broad array of variables, tending to focus instead on individual factors such as stressful life events, negative parenting, maternal depression, and genetic risk. In addition, due to the expense and difficulty of collecting cortisol samples (with the latter a concern in studies of young children; Kryski, Smith, Sheikh, Singh, & Hayden, 2011), research has tended to use small sample sizes and inconsistencies in how cortisol reactivity is elicited, sampled, and indexed are pervasive. These concerns limit the ability to apply basic research findings on early experience and stress biology to preventative interventions for children experiencing severe stress, such as maltreatment and neglect, early in life (Gunnar, Fisher, & The Early Experience, Stress and Prevention Network, 2006).

This review will synthesize key domains of research on predictors of children's cortisol reactivity that have to date proceeded largely in isolation: life stress, parenting,

parent psychopathology, and specific genes, the most frequently studied biological and contextual correlates of HPA axis reactivity in the literature to date. Research examining the associations of these variables on basal cortisol, or trait-like HPA axis functioning (Gunnar & Talge, 2008), and cortisol reactivity, a marker of HPA axis reactivity, will be reviewed. The goal of this review will be to argue that these independent variables should be examined within a multivariate framework as they relate to HPA axis activity (both basal and reactivity), as some of these individual predictors may represent overlapping risks. Such an approach will foster a more fine-grained analysis and identification of key early factors that shape children's cortisol function.

Life Stress and Child Cortisol

Given that a key function of the HPA axis system is to facilitate effective stress responding, and in light of the strong associations between stress and depression onset in both adulthood and adolescence (Hammen, 2005; Harkness, Bruce, & Lumley, 2006), exposure to life stressors has frequently been examined in relation to cortisol reactivity, especially in the context of work on depression risk. Retrospective studies have reported associations between severe early stress, such child abuse and maltreatment (Cicchetti & Rogosch, 2001; Harkness et al., 2011; Kaufman et al., 1997), and increased HPA axis reactivity, as well as less severe but more chronic stressors, such as low socioeconomic status (Lorant et al., 2003; Lupien, King, Meaney, & McEwen, 2000; Smider et al., 2002). In addition, exposure during childhood to early forms of chronic stress, such as abuse or neglect (Harkness, Bruce, & Lumley, 2006) and maternal stress (e.g., maternal depression symptoms and maternal parenting stress; Essex et al., 2002), may sensitize individuals to the negative effects of later stressors. Overall, this research highlights the importance of chronic and enduring stress in shaping cortisol reactivity.

Cortisol levels are responsive to both social stressors, particularly those emerging from close interpersonal relationships, and low social support (Adam, Klimes-Dougan, & Gunnar, 2007; Gunnar & Donzella, 2002; Repetti et al., 2002). In the context of early childhood, parental marital functioning may index and influence these risks, as well as marking the presence of negative influences on other developmental processes, such as the child's ability to regulate emotional states (Gottman & Katz, 1989). Research suggests that the impact of marital discord on the child may be twofold, impacting both the quality of parenting provided to the child (Erel & Burman, 1995; Keller & Davies, 2005), as well as the broader family context (O'Leary, 2013; Pendry & Adams, 2007). Pendry and Adam (2007) found that higher parental marital functioning was significantly associated with lower cortisol levels in 32 kindergarten-aged children and 31 adolescents, and this effect was independent of the impact of marital functioning on parenting. Notably, these researchers examined only basal cortisol levels assessed at waking and bedtime, not reactivity, and did not have an adequate sample size to permit analyses that would tease apart potential overlap between marital functioning and parenting in predicting cortisol levels. As previous research indicates strong interrelatedness of marital discord and parenting (Erel & Burman, 1995), larger samples are needed to detect unique effects of each on children's cortisol function.

It is important to note that a review of this literature shows that life stress is related to both higher (Gunnar, 2000; Gunnar, Morison, Chisholm & Schuder, 2001; Koch et al., 2010; Saridjan et al., 2010) and lower levels of children's HPA activity, both at the level of basal cortisol and cortisol reactivity (Heim, Newport, Bonsall, Miller, & Nemeroff, 2001; Ronsaville et al. 2006), while others have found no relationship between stress and cortisol function (Groeneveld et al., 2012). However, methodological issues related to how cortisol reactivity has been assessed may have contributed to the variability in findings (Gunnar &

Donzella, 2002; Lopez-Duran, Hajal, Olson, Felt, & Vazquez, 2009). Many of the tasks that have been used to elicit cortisol reactivity in childhood do not incorporate features that have been shown to best elicit cortisol reactivity in adults (Dickerson & Kemeny, 2004) and children (Gunnar, Talge, & Herrera, 2009; Kryski et al., 2011), such as negative social evaluation, motivation, and uncontrollability. Importantly, Kryski and colleagues (2011) demonstrated that a task incorporating these characteristics is capable of effectively eliciting cortisol reactivity in early childhood.

Additionally, the mixed findings in this literature may be partially attributable to heritable factors that influence reactivity to psychosocial stress, as well as shared variance between familial psychopathology, genetic vulnerabilities, and psychosocial stress. Regarding the former point, children may be more or less susceptible to the effects of life stress as a function of their familial psychopathology history, or underlying genetic predisposition (i.e., following a diathesis-stress model, Monroe & Simons, 1991). Alternatively, children may be more likely to encounter life stress due to selective processes related to biological or familial predisposition (gene-environment correlation). Indeed, while research findings generally support social causation models described previously, in which exposure to life stress results in higher rates of depression (Costello, Compton, Keeler, & Angold, 2003; Monroe, Slavich, & Georgiades, 2009), social selection may also result in greater exposure to stress in children of depressed caregivers (Johnson et al., 1999). As such, these children may display dysregulated cortisol not only as a result of exposure to life stress but as a function of their underlying biological predisposition, which is correlated with adverse environmental conditions. One salient form of stress often linked to familial risk for depression is poor parenting (Ormel, 2014); I review this literature and its links to child cortisol function in the following section.

Early Caregiving and Child Cortisol

Poor parenting is a key predictor of negative child outcomes in general (O'Connor & Scott, 2007), including childhood depression's onset and course (Ormel, 2014), and a review of the literature on family functioning and child outcomes by Repetti et al. (2002) concluded that unsupportive parenting (including low levels of parental involvement, support, and warmth) is a key factor implicated in negative child developmental outcomes. Repetti and colleagues proposed that the effects of poor parenting on children's HPA axis activity may be an important pathway through which family factors influence child outcomes (2002). Indeed, there is ample evidence associating parenting quality with children's stress hormone functioning (Gunnar, Brodersen, Nachmias, Buss, & Rigatuso, 1996; Gunnar & Donzella, 2002), with negative parenting being strongly linked to child cortisol function (Gunnar & Vazquez, 2006). Research has found associations between poor parental care and cortisol functioning in both animals (Coplan et al., 1996) and infants (Bugental, Martorell, & Barraza, 2003), with low maternal responsiveness associated with elevated cortisol levels in infants (Blair et al., 2008; Morelius, Nelson, & Gustafsson, 2007). A similar effect on basal cortisol has been reported when mothers use withdrawal as a control tactic (Bugental et al., 2003), while physical punishment has been associated with heightened cortisol reactivity to stress (Bugental et al., 2003).

Parenting has also been shown to both moderate and mediate the effects of other environmental variables on children's cortisol functioning. For example, positive parenting has been shown to buffer against the effects of negative life events on child cortisol reactivity (Hagan et al., 2011) while negative parenting practices have been shown to mediate the effect of low socio-economic status on child diurnal cortisol levels in a large sample of families (Zalewski, Lengua, Kiff, & Fisher, 2012); family stress is frequently positively associated

with harsh and generally poor quality parenting (Bradley & Corwyn, 2002; Conger & Donnellan, 2007; Grant et al., 2003). Taken together, this literature suggests that it is important to look at both poor parenting and other forms of life stress together in conjunction to better understand their unique effects on child cortisol functioning.

Familial Risk for Depression and Child Cortisol

Familial psychopathology, particularly depression, is a well-established risk marker for a range of negative outcomes in offspring, including depressive, anxious, and substance use disorders (Goodman & Gotlib, 1999; Weissman et al., 2006). Additionally, offspring of depressed mothers exhibit greater elevations in basal cortisol (Essex et al., 2011), heightened cortisol in response to a psychosocial stressor very early in life (Azar, Paquette, Zoccolillo, Baltzer, & Tremblay, 2007; Brennan et al., 2008; Dawson, Hessel, & Frey, 1994; Feldman et al., 2009), and increased waking salivary cortisol levels (Mannie, Harmer, & Cowen, 2007). However, the mechanisms linking parent depression and offspring vulnerability, including cortisol function, are complex, and likely involve an array of biological and environmental mechanisms, many of which are correlated. In a rare instance in which other relevant influences on children's cortisol associated with maternal depression were examined, Mannie and colleagues (2007) found that the pronounced increase in waking salivary cortisol levels (cortisol awakening response) in children at familial risk for depression was not accounted for by differences in parent-reported parenting behavior, life events, or parental neuroticism. However, these data should be interpreted with caution as parent-report questionnaires pertaining to self-evaluative information, such as parenting style questionnaires, may be biased when collected in the context of depression (Beck, 1967; Rehm, 1977; Richters, 1992; Wisco & Nolen-Hoeksema, 2010a; 2010b). While observational measures of parenting have the limitation of obtaining a relatively brief sample of behaviour, they reduce the impact of

caregiver social desirability or mood-related biases on parenting measures and have strong predictive validity for child outcomes, superior to that associated with self-reported parenting (Zaslow et al., 2006).

Aside from Mannie and colleagues (2007) few studies have attempted to distinguish the effects of the environment, such as poor parenting, from genetic risk for depression on the HPA axis. Children of parents with depression exhibit higher cortisol levels, especially when the parent suffers from current depression (Young, Vazquez, Jiang, & Pfeffer, 2006). This literature complements a host of other findings demonstrating that exposure to maternal depression during the first few years of life is particularly important in shaping children's cortisol reactivity (Ashman et al., 2002; Essex et al., 2002; Halligan et al., 2004). Such work indicates that the timing of children's exposure to depression may be important, and also tentatively speaks to the question of whether risk is transmitted through biological versus environmental mechanisms. Research demonstrating that maternal withdrawal in depressed mothers is associated with higher basal cortisol levels in infants suggests the importance of early exposure to maternal depression (Murray et al., 2010). Other research suggests that there is a sensitive period of exposure to maternal depression during the preschool years during which children are particularly vulnerable (Naicker, Wickham, & Coleman, 2012). Further, recent research suggests that the effect of timing of maternal depression may moderate parenting in shaping children's cortisol reactivity. Dougherty, Klein, Rose, and Lupton (2011) found that parents who had a history of depression and who were more hostile in observed parent-child interactions had children who displayed increases in cortisol in response to a laboratory stressor. Importantly, this relationship only existed when children were exposed to maternal depression during their first few years of life (Dougherty et al., 2011), highlighting the importance of examining the timing of maternal depression when

exploring its effects on depression risk in offspring. Importantly, depression is associated with poorer quality parenting, even after depression has remitted (Lovejoy et al., 2000); thus, even in samples in which parents are not currently depressed, disentangling the impact of depression history and poor parenting on child outcomes may still be important.

There is further evidence that parental depression and parenting behavior independently contribute to children's HPA axis functioning, beyond the impact of depression. For example, Azar and colleagues (2007) found that both lifetime depression in mothers, as well as maternal over-control, were independently associated with children's cortisol reactivity, such that children who had a mother with lifetime depression or a mother without depression who was overcontrolling had greater cortisol reactivity than children whose mothers were not overcontrolling or did not have a history of depression. Interestingly, the relationship found between maternal lifetime depression and children's increased cortisol reactivity was not accounted for by maternal depression during the child's life, as has been found in previous research (Dougherty et al., 2011).

To summarize, the literature reviewed here suggests that both familial depression history and parenting influence children's cortisol reactivity (Granger et al., 1998); however, further efforts are required to disentangle the effects of familial depression and parenting, especially given literature showing that maternal depression is associated with aspects of negative parenting behaviors that are present even when mothers are not currently depressed. (Beavers, Rohde, Stice, & Nolen-Hoeksema, 2007; Lovejoy et al., 2000).

Candidate Genes and Child Cortisol

5-HTTLPR. The serotonin transporter (5-HTT) gene has received attention in studies examining genetic vulnerability to life stress, especially with respect to a polymorphism in the promoter region of this gene (5-HTTLPR) (Caspi et al., 2003; Uher &

McGuffin, 2008). The short allele (*s* allele) of 5-HTTLPR is thought to result in reduced transcription of 5-HTT relative to the long allele (*l* allele; Lesch et al., 1995), and has more been linked to lower levels of 5-HTT mRNA and lower 5-HTT expression (Heils et al., 1995; Lesch et al., 1996). While the literature implicating this genetic variant in depression risk is mixed and controversial (e.g., Karg, Burmeister, Shedden, & Sen, 2011; Risch et al., 2009), interest in the role it plays in developmental psychopathology remains high, with work suggesting it influences a number of potentially important processes relevant to depression (e.g., Hayden et al., 2008; 2010; 2013; Gibb, Benas, Grassia, & McGeary, 2009; Li & Lee, 2014).

This gene has also been hypothesized to influence HPA axis function, with animal studies providing some evidence that 5-HTT variation impacts HPA activity (Barr et al., 2004; Jiang et al., 2009). Research with humans has found that the short allele of 5-HTTLPR is associated with higher basal cortisol levels (Chen et al., 2009; O'Hara et al., 2007; Wüst et al., 2009) and greater cortisol reactivity in both children and adults (Alexander et al., 2009; Gotlib et al., 2008; Jabbi et al., 2007; Mueller et al., 2010; Way & Taylor, 2010), although some findings suggest that this association differs by gender, specific features of neuroendocrine function such as receptor sensitivity, and personality factors such as trait neuroticism (Jabbi et al., 2007; Wankerl et al., 2010; Wüst et al., 2009; Verschoor, 2011). However, other studies have reported no relationship between 5-HTTLPR and cortisol reactivity (Bouma, Riese, Nederhof, Ormel, & Oldehinkel, 2010). The mixed findings in this literature to date could indicate that other variables that influence cortisol reactivity, such as the environment, need to be taken into account as moderators of genetic influences on cortisol reactivity (e.g., Armbruster et al., 2011; Barr et al., 2003; Caspi et al., 2003). Following diathesis-stress models (Ingram & Luxton, 2005; Monroe & Simons, 1991), not

all children show negative outcomes in the context of early stress, such as caregiving or stressful life events, with some children demonstrating the capacity for positive adaptation despite less than optimal parenting or high life stress (Luthar, 2006; Masten, 2007).

Gene-environment interaction may be operating whenever there is evidence for marked variation in responses to environmental risk (Moffitt, Caspi, & Rutter, 2005), as is the case in children's responses to early parenting (Pluess & Belsky, 2010); such interactions may also be important predictors of individual differences in cortisol reactivity to stress, such that heightened reactivity emerges in those with a genetic predisposition who are also exposed to environmental factors that shape HPA axis development. Although the literature testing measured gene-environment interaction in psychopathology is controversial (Dick, 2011; Moffitt, Caspi, & Rutter, 2006), given the dynamic influence of the environment on cortisol function (Miller, Chen, & Zhou, 2007), such interactive processes seem likely to play an important role in cortisol function.

Consistent with this notion, research over the last decade has attempted to identify genetic variants that increase risk for neurobiological dysregulation and psychopathology in the context of stress (Armbruster et al., 2011; Barr et al., 2003; Caspi et al., 2003; Lesch et al., 2010; Mueller et al., 2011; Ouellet-Morin et al., 2009). With respect to such work, the association between genes in the serotonin pathway and cortisol reactivity to laboratory stress may be moderated by the experience of stressful life events (Armbruster et al., 2011). In particular, this type of gene-environment interaction for cortisol reactivity has been examined in adults, with Alexander and colleagues finding that men homozygous for the s allele with a significant history of life events exhibited exaggerated cortisol reactivity in response to psychosocial stress, relative to men with at least one l allele and s homozygotes without a history of life events (2009). This finding has been replicated in a sample of young adults

aged 18-31 (Mueller et al., 2011), although researchers have failed thus far to replicate this finding in children (Mueller et al., 2011). For example, Mueller and colleagues (2011) examined interaction between 5-HTTLPR genotype and stressful life events in predicting reactivity to psychosocial stress in a sample of 115 children aged 8-12, finding a main effect of the 5-HTTLPR but no interaction with stress in this age group. Other studies have failed to find an interaction between 5-HTTLPR and variables such as attachment style in predicting cortisol reactivity in toddlers (Frigerio et al., 2009), although the sample in this study was also small. Indeed, most research examining interactions between 5-HTTLPR and behavioural phenotypes in association with cortisol reactivity tends to use smaller sample sizes (i.e., Ns around 100), likely due to the expense entailed in assessing cortisol reactivity (e.g., Frigerio et al., 2009; Mueller et al., 2011). While the specific sample size required to detect a genetic influence on cortisol reactivity is unknown, most would agree that sample sizes in this range may have limited power to detect smaller genetic effects (Hong & Park, 2012).

BDNF val66met. Brain-derived neurotrophic factor (BDNF), a member of the neurotrophin family of growth factors, is hypothesized to influence neuroendocrine responses to stress. BDNF is a key component of models that view neurobiological responses to stress as playing a central role in understanding the pathophysiology of stress-related disorders (Duman & Monteggia, 2006). BDNF is widely expressed in the brain and is implicated in neurogenesis, differentiation, survival, and synaptic plasticity (Bath & Lee, 2006; Bergstrom et al., 2008); further, animal research indicates that BDNF influences HPA axis activity in rats (Givalois et al., 2004; Naert et al., 2006), suggesting that BDNF may be involved in mechanisms underlying HPA axis function in humans.

A single nucleotide polymorphism in the BDNF gene consisting of a valine (val) to

methionine (met) substitution at codon 66 (val66met) has been the focus of most research. The less common met variant has been associated with reduced BDNF activity (Chen et al., 2004), reduced hippocampal volume (Frodal et al., 2007), and impaired memory and hippocampal function (Hariri et al., 2003; Matsuo et al., 2009), and has been linked to anxiety-like symptoms in animals (Chen et al., 2006) and stress-related symptoms in humans (Kim et al., 2007; Wichers et al., 2008). In addition, studies of humans have reported an association between the BDNF val66met polymorphism and HPA axis activity; for example, Schule et al. (2006) found that met homozygotes evidenced greater HPA axis activity, and Shalev et al. (2009) found that female met carriers exhibited a greater rise in cortisol in response to a laboratory challenge than val homozygotes, whereas the opposite was found for males suggesting that moderation by child sex should be explored in future research. Colzato and colleagues (2011) found that met carriers had a higher anticipatory cortisol response to laboratory stressor than val homozygotes. In contrast, another paper reported that met carriers evidenced an attenuated cortisol response to psychosocial challenge relative to val homozygotes (Alexander et al., 2010). Thus, like the findings concerning 5-HTTLPR, the lack of consistency in this literature suggests that environmental moderators may have been omitted from these models, which would be consistent with a small literature suggesting that the BDNF met allele confers increased sensitivity to both positive and negative environments (Hayden et al., 2010), or that samples may have been too small to detect genetic effects. Despite the inconsistency in the current literature examining BDNF val66met genotype and cortisol, evidence exists for an association between BDNF val66met and depression, particularly in the context of life stress, supporting the notion that BDNF may be a genetic factor that shapes the development of cortisol dysregulation (Hosang, Shiles, Tansey, McGuffin, & Uher, 2014).

In summary, while research examining associations between these two variants and cortisol activity suggests that both play a role in shaping the HPA system (Goodyer et al., 2010), findings are inconsistent regarding which variants increase risk and whether environmental moderators are important. It should be acknowledged that biochemical activity in any of these systems (such as serotonin) is a function not of a single gene but of a series of genes that interact to shape the synthesis and metabolism of the transmitter and its binding to its receptors (D'Souza & Craig, 2006). This means that single gene associations may be difficult to replicate if the effects of one gene are small. While adequate sample sizes help with this issue, another way to increase power is to use precise measures of the phenotype of interest, thus mitigating the need for a very large sample by reducing measurement error (Moffitt, Caspi, & Rutter, 2005). Additionally, these mixed findings may indicate that interactive effects between genetic variants and environmental factors, such as parenting and life stress, need to be accounted for in order to gain a full understanding of which genes play a role in shaping stress sensitivity, indexed via cortisol reactivity.

The Current Study

There is no question that the development of a complex psychophysiological system such as the HPA axis is shaped by multiple, potentially overlapping biological and contextual factors, although most previous research has focused on individual factors in isolation. This study seeks to address this complexity by testing broader models that include multiple domains previously implicated in children's cortisol stress reactivity, such as biological risk markers (i.e., specific genes), as well as contextual factors (i.e., parenting and life stress) and parent depression, which reflects both biological and contextual risk.

As reviewed, genetic polymorphisms (especially 5-HTTLPR and BDNF val66met) have been explored independently in association with cortisol reactivity, and as such, these

variables were examined as genetic influence in this study. Parent depression can reflect both biological and contextual risk and will be conceptualized as both a biological and contextual risk variable in analyses. A multi-method approach to assessing environmental factors that may shape children's cortisol reactivity was used, tapping negative parenting and life stress assessed using observational, interview, and questionnaire measures. The specific goal of this research was to better understand how parent depression, specific genes (5-HTTLPR and BDNF val66met), parenting, and life stress influence cortisol reactivity in early childhood, both in terms of main effects and interactions between familial and contextual risk.

Another major goal of this study was to improve upon the methodology used in previous work examining predictors of children's cortisol reactivity to stress. Studies examining familial risk for psychopathology together with parenting often use self-reports of both constructs, increasing the potential for shared method variance or parent bias to influence findings. More specifically, self-reports of parenting may be biased as individuals may over- or underestimate the quality of their parenting ability, particularly when they suffer from mental health problems (Chilcoat & Breslau, 1997; De Los Reyes & Kazdin, 2005; Najman et al., 2001). The current study used a multi-method approach comprised of largely independent methods of assessment to examine the relationship between biological and contextual risk factors and children's HPA axis reactivity. This study also used a stress task known to elicit a mean increase in cortisol in this age group (Kryski et al., 2011), an effect that is frequently not achieved by many paradigms used with young children (e.g., Dougherty et al., 2011; Lewis & Ramsey, 2002). In addition, as cortisol recovery following a stressor may be as critical to assess as reactivity, since impairments in the capacity to downregulate the cortisol system following a stressor leads to increased exposure to the hormone (Linden, Earle, Gerin, & Christenfeld, 1997; Sapolsky et al., 2000), this study

sampled cortisol at multiple time points across a fairly extensive post-stress period.

As this study is the first to examine a broad range of familial and contextual variables in influencing children's cortisol reactivity, I took an exploratory approach to hypothesis testing, albeit one grounded in past research when relevant work was available. I expected that familial risk for depression indexed by parental history of depression, 5-HTTLPR and BDNF val66met genotypes, as well as contextual stressors such as life stress, and parenting, would predict unique variance in children's cortisol reactivity, despite the potential for these risks to overlap with one another (e.g., parent depression and life stress). However, it is also likely that biological and contextual variables interact to predict children's cortisol reactivity, with indices of biological risk previously linked to heightened reactivity having an impact only under adverse environmental contexts (e.g., Dougherty et al., 2011).

I tested these main effects and interactions in a sample of 409 three-year-old community-dwelling children from southwestern Ontario with the aim of developing a more comprehensive model of the development of cortisol reactivity to stress. This study indexed cortisol reactivity in two ways: area under the curve and multi-level modeling. Each of these indices likely represents a slightly different physiological process within the HPA system (e.g., baseline cortisol, reactivity, and recovery), although previous studies have typically focused on only one of these. Examining multiple cortisol indices permits the identification of unique and shared predictors of each index, and facilitates linking my findings to previous literature.

In order to better understand the transmission of familial risk for depression, the role of maternal and paternal depression risk will be explored separately. The role of paternal depression as a risk marker of depression risk has been largely ignored in the extant

literature, despite meta-analytic support linking it to child internalizing psychopathology (Kane & Garber, 2004). The paucity of research linking paternal depression and child cortisol is even more pronounced, with the vast majority of literature focusing only on maternal depression (for exceptions see Mackrell et al., 2014; Laurent et al., 2012). As a preliminary, admittedly limited test of whether the effect of parent depression on child cortisol requires direct exposure to a parent's depressive episode, I examined both parent depression experienced during the child's lifetime and at any point in the parent's lifetime.

Method

Participants

Participants were an unselected community sample of 409 children (201 boys; 49%) between 3- and 4-years old ($M = 3.44$, $SD = 0.30$) and their caregivers recruited for a study of child emotional development. Children were recruited by contacting families through a university's research participant pool and by advertisements placed in local daycares, preschools, recreational facilities, and on websites. Children with significant medical or psychological problems were excluded from participation via a screening procedure administered by trained study personnel at the recruitment stage. The mean age of primary caregivers was 34.00 years ($SD = 4.85$) and they were usually children's mothers ($N = 382$; 93%). Family income varied widely (4% < \$20,000; 11% = \$20,000-\$40,000; 24% = \$40,001-\$70,000; 30% = \$70,001-\$100,000; 31% > \$100,001). Children were mostly Caucasian (93%) and of average cognitive ability ($M = 112.00$, $SD = 14.04$) as assessed by the Peabody Picture Vocabulary Test-Fourth Edition (PPVT; Dunn & Dunn, 2007). The remainder of children were identified as Asian (2%), African-Canadian (0.5%), Hispanic (1.7%), or other/mixed race (2.4%). The family demographic data for this sample closely resembles the most recent London, Ontario census data available (Statistics Canada, 2006).

See Table 1 for a summary of sample characteristics.

Procedure

Data were collected in three waves. The first wave, collected over a period of 2 years, consisted of a 2-hour laboratory visit during which child DNA and observed parenting data were collected, a 2.5-hour home visit conducted within approximately two weeks ($M = 2.32$, $SD = 1.78$) of the laboratory visit during which child cortisol data and observed parenting data were collected, and a set of questionnaires from which data on basic demographic information, marital discord, and parenting was gathered. Primary and secondary caregivers completed separate ratings of marital discord as well as self and informant reports of parenting as data from multiple informants has been shown to be differentially associated with child outcomes (Burt et al., 2005). The second wave began approximately 15 months after the initial laboratory visit and consisted of a telephone interview during which information on chronic life stress was obtained from the primary caregiver. The third wave began approximately 30 months after the initial laboratory visit and consisted of a telephone or face-to-face interview during which a structured clinical interview covering parents' history of depression and anxiety also occurred. See Figure 1A in Appendix A for a graphical representation of the time frame during which data were collected.

Cortisol Reactivity to Stress

Each child participated in a stress task (Kryski et al., 2011) adapted from previous work by Lewis and Ramsey (2002) in which 4-year-old children matched colored stickers to four different animals on a worksheet using a key. Observations of pilot participants indicated that this task was too challenging for three-year-olds; therefore, the task was simplified to make it developmentally appropriate for younger children, and was further

Table 1

Sample characteristics

Variable	N (%)	Mean (SD)
<i>Child Sex</i>		
Males	201 (49.1)	
Females	208 (51.7)	
<i>Child Age (years)</i>		3.44 (0.3)
<i>Child PPVT Scores</i>		112.0 (14.0)
<i>Child Race/Ethnicity</i>		
Caucasian	382 (93.4)	
African-Canadian	2 (0.5)	
Asian	8 (2.0)	
Hispanic	7 (1.70)	
Other/Mixed	10 (2.4)	
<i>Primary Caregiver Age</i>		34.0 (4.9)
<i>Maternal Age</i>		33.3 (4.6)
<i>Paternal Age</i>		35.0 (4.9)
<i>Primary Caregiver Identity</i>		
Mother	382 (93.4)	
Father	26 (6.4)	
Other	1 (0.2)	
<i>Family Income</i>		
< \$20,000	16 (4.1)	
\$20,000-\$40,000	44 (11.3)	
\$40,001-\$70,000	92 (23.7)	
\$70,001-\$100,000	115 (29.6)	
> \$100,001	122 (31.4)	

modified to include a greater number of features thought to increase cortisol reactivity (Dickerson & Kemeny, 2004; see section describing task stimuli). Trained study personnel conducted this task during a visit to the child's home. Families' homes were chosen as the setting for this assessment in part to reduce the influence of a novel laboratory setting on children's cortisol levels (Gunnar & Talge, 2008). To further reduce irrelevant influences on cortisol, all children were already familiar with the female experimenter conducting the cortisol task, having met her previously during a visit to a research laboratory for other study procedures. All home visits began between 12:00pm and 3:30pm to address diurnal variation in children's cortisol levels, as cortisol levels are more stable in the early afternoon than at other times of day (Schmidt-Reinwald et al., 1999). Parents were instructed to not allow their child to eat or drink anything but water for one half hour prior to the visit, as certain substances, such as bovine cortisol in milk products, can cross-react with anti-cortisol antibodies and cause erroneous results in cortisol assays derived from human saliva (Magnano, Diamond, & Gardner, 1989), and because acidic or high sugar foods can alter saliva pH and compromise assay performance (Salimetrics, 2008).

At the beginning of the home visit, the child and experimenter played together quietly with a set of standardized toys (e.g., books, coloring, children's videos, blocks, sticker, and puzzles) for 30 minutes. This quiet play period was to allow any increases in salivary cortisol due to the arrival of study personnel to dissipate before baseline samples were taken. During this time, the child was encouraged to stay seated and engage in minimal activity, as cortisol levels are also influenced by high levels of physical activity (Wellhoener, Born, Fehm, & Dodt, 2004). After 30 minutes had passed, a baseline salivary cortisol sample was collected, followed by the stress task described below. Following the stress task, the child and experimenter again resumed quiet play while the remaining cortisol samples were

collected at 10, 20, 30, 40, and 50 minutes post-stressor. The stress task was videotaped by a female research assistant for subsequent coding of affective responses to the task and to increase the social-evaluative nature.

Stress task. To assess children's psychophysiological reactivity to stress, each child participated in a color-matching game that was designed to be impossible to successfully complete. For the task, each child and the experimenter were seated beside each other at a table (usually a dining room or kitchen table) in front of a large felt board on which numerous bear and frog icons had been affixed. A large toy replica of a traffic light with a green, yellow, and red light was placed adjacent to the board, and the experimenter had an unobtrusive remote control used to manipulate the traffic light. A research assistant operating a video camera was seated opposite the experimenter and child to videorecord the task and to contribute to the social-evaluative nature of the task.

At the beginning of the task, the child was allowed to choose a prize from an assortment of small toys. The desired toy was then placed where the child could see it. The child was told that the experimenter would like them to play a matching game. Children were told that each bear on the felt board should be matched to a blue colored ball and that each frog should be matched to a red colored ball (the "balls" being blue and red game pieces with adhesive Velcro backing to allow them to adhere to each animal on the game board). The child was shown how to place each game piece of the appropriate color on a bear or frog on the board based on a key at the top of the board. To ensure comprehension of the task, children were given several opportunities to practice matching the animals with the correct color game piece prior to starting the task. The child was then told that he or she did not have much time to complete the task, and that the traffic light would show how much time they had to finish. More specifically, the children were told that they had plenty of time to work

when the light was green, but that when the light turned yellow they were running out of time, and that when the light turned red, they were out of time. The red light was accompanied by a loud buzzer sound. The experimenter demonstrated each light color for the child while explaining the meaning of each light. Children were told that they must match all the animals on the board with the right “ball” to get their preferred prize (the previously selected toy). If they did not finish in time, children were told that they would receive a sticker instead (actually a white hole punch reinforcement). To enhance the stress-inducing nature of the task, children were also told that matching all the pieces was easy to do, and that even “little kids” could do so.

The matching portion of the task began when the experimenter cued the child to start matching by saying “ready, set, go.” For most children, the green light on the stoplight was allowed to shine for 2 minutes and 20 seconds. Next, the light was changed to yellow and the experimenter exclaimed that the child was running out of time. After another 40 seconds, the experimenter switched the light to red, which triggered the loud buzzer. At this time, the experimenter told the child that they did not finish in time and that they would not get the preferred toy; instead, children were given the white “sticker” (i.e., the hole punch reinforcer). Throughout the task the child was corrected verbally and the adhesive piece removed whenever a game piece was matched incorrectly, and the experimenter recorded how many pieces the child placed correctly and incorrectly for each consecutive trial. After the first attempt to complete the matching task, two subsequent and identical trials occurred in which children were again unsuccessful at finishing the task. Upon the third failure, the experimenter looked at the stop light in a puzzled fashion, and explained to the child that the light was broken and that the child hadn’t been given enough time to finish the task. The child’s matching skills were then praised and the child received his or her preferred toy. We

previously showed that this task successfully elicits an initial cortisol increase and subsequent decline (Kryski et al., 2011). As further evidence of this task's stress-inducing nature, coding of child affect during the introduction and stressful portion of the task showed a significant increase in child negative affect and a significant decrease in positive affect as the task progressed (Kryski et al., 2011).

Cortisol sampling procedures. As previously described, cortisol samples were obtained at baseline immediately before the introduction of the stress task and at ten-minute intervals following completion of the task, for a total of five samples post-stressor. To facilitate accurate timing of the sample collection, as well as to record the time the samples were obtained, the start and stop times of the matching task and each cortisol sample were recorded.

To collect saliva, children were asked to chew on an absorbent cotton dental roll until it was wet. To facilitate sampling with three-year-olds, collection procedures were presented as a game in which the child raced the main experimenter to get a few grains of Kool-Aid out of a colorful Dixie cup, receiving stickers upon completion of each sample. The child received a new cup and dental roll for each "game" to avoid cross-contamination of samples. This approach not only made sampling pleasant for the child, thus enhancing compliance, but also promoted the flow of saliva since the Kool-Aid stimulated the salivary glands. Kool-Aid was used sparingly, and previous work shows that its use does not compromise the quality of the assays as it does not significantly alter the pH of the saliva (Talge et al., 2005). Red-colored Kool-Aid was used as the color red has an optical density of upwards of 600nm and is the least likely to interfere with assay protocol.

Sampling non-compliance was very low (2.1%; 51 out of the 2454 samples that study personnel attempted to collect); 392 children provided all six cortisol samples (95.8%)

while the remaining seventeen children (4.2%) did not provide a sample at at least one time point (four children refused all samples, < 1%). Non-compliance rates for cortisol sampling with young children generally range anywhere for 8-10% (Blair et al., 2008; Lewis & Ramsay, 2002; Mills et al., 2008); thus, compliance was exceptionally high in the current study.

After the collection, saliva was expunged into a micro tube and frozen at -20c until assayed in duplicate using an expanded range, high sensitivity, salivary cortisol enzyme immunoassay kit (Salimetrics, PA, USA). Optical density was read on a standard plate reader at 450 nm and corrected at 650 nm (Molecular Devices, Sunnyvale, CA, USA). All samples from the same child were assayed in the same batch with no duplicates varying more than 5%. Enzyme immunoassays were run according to manufacturer instructions and average intra- and interassay coefficients were 3.5 and 5.1% respectively. Studies consistently report high correlations of cortisol levels when comparing saliva to serum concentrations (Daniel et al., 2006; Dorn et al., 2009; Eatough, Shirtcliff, Hanson, & Pollak, 2009). Standard curve and concentration of unknown samples were generated according to manufacturer's instructions using a 4-parameter sigmoid minus curve fit (SPSS 16.0). Cortisol concentrations are reported in micrograms per decilitre (ug/dl)¹.

As markers of overall cortisol output and reactivity, cortisol area under the curve was calculated for each child with respect to ground (AUCg) and increase (AUCi) (Pruessner, Kirschbaum, Meinlschmid, & Hellhammer, 2003). AUCg is an estimate of total cortisol secretion, and the AUCi is an estimate of the change in cortisol that best captures overall reactivity (Pruessner et al., 2003). These two indices are derived using the following

¹ Due to the small unit of measurement for cortisol, unstandardized regression coefficients are small in magnitude even when an effect is robust; as such, cortisol results will be reported to three decimal places to ease interpretation.

equations where m denotes the individual measurements, t the time between measures, and n the total amount of measures:

$$AUC_G = \sum_{i=1}^{n-1} \frac{(m_{(i+1)} + m_i) \cdot t_i}{2}$$

Equation 1 (Pruessner et al., 2003)

$$AUC_I = \left(\sum_{i=1}^{n-1} \frac{(m_{(i+1)} + m_i) \cdot t_i}{2} \right) - \left(m_1 \cdot \sum_{i=1}^{n-1} t_i \right)$$

Equation 2 (Pruessner et al., 2003)

AUCg and AUCi were calculated using raw cortisol values, although the final scores were positively skewed, as is typical for such measures, and thus were log10 transformed prior to analysis (Gunnar & Talge, 2008). As both AUCg and AUCi contained either negative values (AUCi) or values less than 1 (AUCg and AUCi), a constant was added to bring the minimum AUC values to 1 prior to performing the log transformation.

Assessment of Parenting

Parenting data were collected via observed ratings of parenting behavior and self and informant ratings of parenting style. The methods for collecting these data are described as follows.

Observed parenting. Two semi-structured parenting tasks (the three-bag and prohibition tasks) were conducted in the home following the cortisol assessment described previously; all 409 primary caregivers completed these two tasks although a technical issue resulted in data being unavailable for one participant. A third parenting task was conducted during a separate laboratory visit during which child genetic data were obtained; videorecorded data were collected for all 409 primary caregivers for this task. Observational measures of parenting such as these have been shown to have strong predictive validity for

child outcomes (Zaslow et al., 2006).

Three-bag task. This task was based on a protocol developed by the National Institute of Child Health and Human Development (1997), modified by Ipsa and colleagues (Ipsa et al., 2004). The primary caregiver and their child were instructed to play together with three bags of toys. The first bag contained a book, the second contained a set of toy kitchen items, and the third bag contained a farmhouse play set. The pair was told to play with the toys in order and to put away one set of toys before moving on to the next set. This free play paradigm lasted approximately 10 minutes.

Prohibition task. This task was designed to elicit negative parenting behaviours. The primary caregiver and the child were presented with two boxes of toys. The first box contained toys that would be fun or exciting for children in this age group (e.g., a toy electronic guitar). The second box contained unexciting and age-inappropriate toys that were missing pieces or batteries, such as a plastic cone and pieces for Mr. Potato head without the head. Initially, the primary caregiver was instructed to keep his or her child from playing with the appealing toys, thus requiring the caregiver to engage the child in play with the uninteresting toys. After 3 minutes, the primary caregiver was told that they could allow their child to play with the toys in either bin, and after a 6-minute play period, the caregiver was told to have the child put away the toys. The child was then given 5 minutes to tidy up. The experimenter gave instructions to the primary caregiver on printed instruction cards to increase the child's perception that these were the caregiver's commands rather than the experimenter's.

Teaching task. This task was completed during a separate laboratory visit that was conducted approximately two weeks prior to the home visit assessment. Based on the Teaching Tasks battery (Egeland, Weinfield, Hiester, Lawrence, Pierce, & Chippendale,

1995), the primary caregiver and child were presented with a challenging block puzzle and were instructed to work on it together. The puzzle could be solved six different ways to look like pictures on cards provided. To increase motivation for puzzle completion the dyad was told to place the pictures of completed puzzles in the upper corner of the work desk so that the experimenter could see how many they finished after 5 minutes.

Coding of observed parenting. Video-recordings of the laboratory and home parenting tasks were coded by trained graduate and undergraduate raters using a coding manual that was based on the Teaching Tasks coding manual (Weinfield, Egeland, & Ogawa, 1997) and the Qualitative Ratings for Parent-Child Interactions scale (Cox & Crnic, 2003). Raters were trained to an intraclass correlation of .80 with a master coder (this author). Once interrater reliability was established, intermittent reliability checks were performed on 15% of all recordings. Reliability for each task was high (calculated on 15% of videos; three bag ICC = .86; prohibition ICC = .87; teaching task ICC = .90). Coders met periodically and reviewed recordings together to prevent observer drift. Parent-child interaction tasks were coded on a total of 9 Likert scales: sensitivity, detachment, supportive presence, intrusiveness, hostility, confidence, quality of instruction (only coded for the teaching task), positive affect, and negative affect (see Appendix B for the coding manual).

Self- and informant-reports of parenting. Self- and informant- ratings of an abbreviated (32-item) version of the Parenting Styles and Dimensions Questionnaire (PSDQ; Robinson et al., 2001) were completed independently by 405 primary and 367 secondary caregivers, with secondary caregivers providing informant accounts of the primary caregivers' parenting behaviour. Informant data were collected only when an informant was available who had lived with the primary caregiver during the child's lifetime, and thus had opportunity to observe their caregiving. Thus, missing data are due to the absence of a

secondary caregiver as well as the failure of an appropriate secondary caregiver to return completed questionnaires. The PSDQ is designed to measure self- and spouse-reported practices for parents of preadolescent children, and calls for the respondent to describe the frequency of the use of various parenting practices using a 5-point Likert scale response format ranging from never (1) to always (5). The PSDQ is split into 3 parenting domains: authoritative, authoritarian, and permissive. These are further split into parenting sub-dimensions: connection, autonomy, regulation, verbal hostility, physical coercion, non-reasoning/punitive and indulgence. The PDSQ scales have moderate to good internal consistency, as reported elsewhere (Robinson et al., 2001) and in this sample, with alphas ranging from .74 to .92 for informants and .68 to .87 for self-reports in the present study.

Parenting data reduction. To reduce the number of analyses, aggregates of the parenting measures were formed by standardizing and combining relevant scales. The positive parenting scale consisted of a standardized aggregate of the following individual scales: sensitivity, supportive presence, confidence, and positive affect from the three bag, prohibition, and puzzle tasks, quality of instruction from the puzzle tasks, and the connection, autonomy, and regulation subscales from the self- and informant-reports on the PSDQ. Internal consistency for the positive parenting scale was good ($\alpha = .82$). The negative parenting scale consisted of a standardized aggregate of the following individual scales: detachment, hostility, intrusiveness, and negative affect from the three bag, prohibition, and puzzle tasks, and the verbal hostility, physical coercion, non-reasoning/punitive, and indulgence subscales from the self- and informant-reports on the PSDQ. Internal consistency for the negative parenting scale was also good ($\alpha = .78$). Scales were constructed such that children had to have data from at least one index of parenting in order to have a score generated, although most children ($N = 405$; 99%) had both home-observed,

laboratory-assessed, and questionnaire data (either self- or informant- report). As the negative and positive parenting scales were strongly, negatively correlated ($r = -.70$; $p < .001$), these variables were further combined by first reverse-coding positive parenting (so that higher scores reflected less positive parenting) then summing negative parenting and the reversed-coded positive parenting scale. This new variable reflects “poor parenting” and will be referred to as such for the remainder of the paper. After data reduction, a parenting score was available for all 409 participants.

Assessment of Life Stress

Several factors known to serve as sources of early psychosocial stress were examined: familial chronic stress (Burge & Hammen, 1991), marital discord (Hammen, Brennan, & Shih, 2004), and socioeconomic status (SES; Lupien, King, Meaney, & McEwen, 2000).

UCLA Life Events Interview. The UCLA Life Stress Interview (Hammen et al., 1987) was used to assess chronic stress in the family as reported by the primary caregiver. Interviews were conducted by trained Ph.D. candidates from the clinical psychology program at Western University. 401 primary caregivers completed the interview; missing data for the remaining 8 caregivers were due to inability to reach them at the time of assessment. Interviews were conducted over the phone and in-person; phone interviews have been shown to yield similar results to face-to-face interviews (Rohde, Lewinsohn, & Seeley, 1997). All of the training for these interviews was done by a Ph.D. level psychologist, the principal investigator on the larger study for which these data were collected. Following the structure of the interview, interviewers gathered information from the primary caregivers regarding stress in their intimate/romantic relationships, close friendships, social life, family relationships, childcare hassles, work, finances, health of the primary caregivers, and health of close family members (Adrian & Hammen, 1993; Hammen, 1991). The interviewer then

assigned Likert-style ratings to the level of stress present in each domain from low (1) to high (5). These interviews were conducted 15 months after the assessment of child cortisol, and covered the time frame at, and immediately following, the assessment of child cortisol reactivity to stress. As chronic stress is stable over time (Hammen, Kim, Eberhart, & Brennan, 2009), these assessments index chronic stress levels concurrent to children's cortisol assessment. Reliability was assessed by having a second coder rerate the information on chronic stress in each domain for 12 of the interviews (average ICC = .78). Although the number of interviews coded for reliability varies widely in behavioural research, the choice to re-code 12 was based on a review of available past research, although Ns for reliability are frequently not reported (e.g., Connolly, Eberhart, Hammen, & Brennan, 2010; Eames et al., 2014; Raposa et al., 2014). Scores on all domains of chronic stress were averaged to create an overall chronic stress scale.

Marital discord. Primary caregivers' reports of relationship adjustment were collected during the first wave of the study using the Dyadic Adjustment Scale (DAS; Spanier, 1976). The DAS is a 32-item questionnaire of marital adjustment designed for use with either married or unmarried cohabiting couples. The instrument provides a global score of dyadic adjustment that can range from 0 to 151, with higher scores reflecting greater dyadic adjustment. Previous research has demonstrated the reliability and validity of this measure (Baillargeon, Dubois, & Marineau, 1986). In this sample, internal consistency for global dyadic adjustment was good ($\alpha = .92$). DAS data were available for 366 primary caregivers. Missing data were due to the absence of a secondary caregiver (N = 30), failure to return the DAS when it was issued (N = 1), or the secondary caregiver being someone other than a romantic partner (e.g., divorced partner or live-in grandparent; N = 12).

Socioeconomic status. Family income was reported by one caregiver as an index of

family SES. These data were collected on a generic demographic form along with other basic demographic characteristics. Family income scores were generated that ranged from 1 (< \$20,000) to 5 (> \$100,000). The distribution of these scores is in the *participants* section of this paper. Before creating an aggregated life stress variable, family income was reverse-coded so that higher scores reflected lower family income and greater socioeconomic stress. Information on family income was provided by 389 families due to failure to return the demographic form entirely (N = 4) or failure to provide information on family income (N = 16).

Life stress data reduction. UCLA life stress interviews, marital discord, and family income stress were aggregated to form a measure of chronic family stress in the home. Creating such cumulative stress/risk aggregates is a widely used approach in developmental research (e.g., Essex et al., 2002; Nederhof, Ormel, & Oldehinkel, 2014; Pinna, 2012; Suglia et al., 2010; Zalewski, Lengua, Kiff, & Fisher, 2012) and permits the examination of total stress exposure from a variety of sources (e.g., Adrian & Hammen, 1991; Sprague, Verona, Kalkhoff, & Kilmer, 2011). In addition, aggregate measures have been shown to be related to markers of stress *vulnerability* (Lakey & Edmundson, 1993) such as HPA axis reactivity. Family income and DAS scores were first reverse-coded so that higher scores reflected greater socioeconomic stress and greater marital discord, respectively. Next, UCLA chronic stress ratings, family income (reversed), and DAS scores (reversed) were standardized and aggregated to create the final *chronic family stress* aggregate used in analyses. At least two scores were required for the aggregate. After data reduction, a life stress score was available for 406 participants.

Familial Risk Data

Genetic data. DNA was collected at the initial laboratory visit from all 409

participants by gently rubbing the inside of the child's cheek with a buccal swab (Epicentre, Madison, WI, USA), and was extracted using the Qiagen DNA MicroKit® (Mississauga, ON, Canada) according to manufacturer's protocols. Children were genotyped for the serotonin transporter promoter (5-HTTLPR s/l) and BDNF val66met gene variants using allele-specific TaqMan polymerase chain reaction (Sheikh, Hayden, Kryski, Smith, & Singh, 2010). Genotyping was successful for 403 children for the 5-HTTLPR polymorphism and for all 409 children for the BDNF val66met polymorphism. For 5-HTTLPR, genotype frequencies were as follows: l/l = 127 (31%); s/l = 193 (48%); and s/s = 85 (21%). This genotype distribution is consistent with Hardy-Weinberg equilibrium ($\chi^2(1) = .54, p = .46$). For BDNF val66met, allele frequencies were val/val = 258 (63%), val/met = 134 (33%), and met/met = 17 (4%), which is also consistent with Hardy-Weinberg equilibrium ($\chi^2(1) = .01, p = .94$). Although research regarding the functionality of the s variant is mixed, with findings supporting both s dominant (Heils et al., 1996; Kim et al., 2007) and recessive models (Kendler et al., 2005), I treated the s variant as dominant, consistent with the bulk of previous studies (e.g., Hariri et al., 2002; Steiger et al., 2008) and to limit the number of variables in analyses. Consistent with previous literature and due the infrequency of the met/met genotype, the met variant of BDNF val66met was treated as dominant in analyses (Hosang et al., 2014); thus, children with the s/s and s/l genotypes of 5-HTTLPR (N = 278) were contrasted to children with the l/l genotype (N = 127) and children with val/met and met/met genotypes of BDNF val66met (N = 151) were contrasted to children with the val/val genotype (N = 258). As 5-HTTLPR and BDNF val66met genotype frequencies vary amongst different racial groups (Gelernter, Kranzler, & Cubells, 1997; Pivac et al., 2009), all significant genetic associations were reanalyzed excluding non-white participants; these reanalyses yielded highly consistent findings with those resulting from use of the entire

sample, and are therefore not discussed further.

Parent psychopathology. The full Structured Clinical Interview for DSM-IV (SCID; First, Spitzer, Gibbon, & Williams, 1996) was conducted with all biological parents of children in the study when possible. Interviewers were trained Ph.D. candidates in the Clinical Psychology program at Western University and were trained by a Ph.D.-level psychologist and principal investigator on the larger study. Interviewers were not involved in collecting any other study data, and did not have access to any of the data on the children. If a second biological caregiver was unavailable to complete the SCID, a family history interview was conducted with the primary biological caregiver when possible (Andreasen, Endicott, Spitzer, & Winokur, 1977). In total, family history interviews were conducted to collect data for 11 biological fathers.

Diagnostic data on lifetime major depressive disorder (MDD) or current dysthymic disorder (DD) were available for 392 mothers and 349 fathers. Information on the timing of maternal and paternal depression was obtained using the SCID to gain a better understanding of how the effects of parent depression on child cortisol reactivity can be transmitted both biologically and contextually. Comorbidity between depression and anxiety is high, with as many as 67-75% of individuals with depression also meeting criteria for an anxiety disorder (Lamers et al., 2011); as such, information on lifetime history of any anxiety disorder (panic disorder, agoraphobia without panic disorder, social phobia, obsessive-compulsive disorder, post-traumatic stress disorder, generalized anxiety disorder, or anxiety disorder not otherwise specified) was used in the present study in order to examine whether any influence of depression remained when a lifetime history of anxiety was included in models. Interrater reliability for the SCID was computed based on 33 audiotaped interviews (21 mothers and 12 fathers). Interrater reliability was perfect for all diagnoses used in this study (Lifetime MDD

Kappa = 1.00; Current DD² Kappa = 1.00; any Lifetime Anxiety Disorder, Kappa = 1.00).

MDD and DD were collapsed into a single category by coding no history of MDD or DD as 0 and a history of MDD or DD as 1; these variables are referred to as maternal and paternal depression throughout the rest of the thesis (see Table 2)³. In this sample, 23% of mothers and 17% of fathers with a history of either MDD or DD also had a lifetime history of an anxiety disorder. As the timing of parent depression may influence its impact on children (Dougherty et al., 2011), a variable was also created to examine whether maternal depression occurring during the child's lifetime was related to children's cortisol reactivity. This was done by coding maternal depression occurring during their child's lifetime as 1 (N = 67; 17.0%), and coding either no maternal depression history or none during the child's lifetime as 0. For ease of interpretation, the new variable reflecting child exposure to maternal depression during their lifetime will be referred to as children's *maternal depression exposure* throughout the remainder of the paper. As the frequency of paternal depression occurring during the child's lifetime was quite low (N=19; 5.4%), I did not examine children's paternal depression exposure.

Results

Data Analytic Strategy

Multiple cortisol reactivity indices have been used in previous research, including AUC (e.g., Harkness, Stewart, & Wynne-Edwards, 2011; Mackrell et al., 2014; Pruessner et al., 2003) and multi-level modeling (MLM; e.g., Dougherty et al., 2011; Kryski et al., 2011; 2013a; 2013b; Mackrell et al., 2014). Missing cortisol values were imputed for all children with at least one cortisol value using a fully conditional specification method (Graham,

² The SCID assesses current DD only.

³ Very few mothers and fathers had DD in the current study (mother N = 0; father N = 2).

Table 2

Frequency of parent depressive and anxiety disorder

Variable	<i>N</i> (%) with lifetime history of disorder	<i>N</i> (%) with depression during child's lifetime
<i>Maternal Disorder</i>		
Major Depressive Disorder or Dysthymic Disorder	102 (26.0)	67 (17.0)
Any Anxiety Disorder	71 (18.2)	not applicable
<i>Paternal Disorder</i>		
Major Depressive Disorder or Dysthymic Disorder	47 (13.5)	19 (5.4)
Any Anxiety Disorder	31 (8.9)	not applicable

2009), resulting in a sample size of 405 for the dependent variables in both AUC and MLM analyses.

My primary aim was to explore interactions between biological and contextual variables in shaping children's early emerging cortisol reactivity to stress, indexed via AUC_i, AUC_g, and by using MLM. Having said that, our sample size, while large for this kind of study, would not permit testing all two-way interactions in our sample, nor were all two-way interactions thought to be equally important or anticipated based on previous research (e.g., Dougherty et al., 2011; Mueller et al., 2011). For these reasons, I made the a priori decision to focus on interactions between familial/heritable and contextual variables in the current study⁴; specific interactions terms included in AUC and MLM models will be listed in the corresponding sections. As parent depression likely impacts children via both genetic and environmental pathways, parent depression was treated as a marker of both familial/genetic and contextual risk in interactions.

Separate models were run examining the effects of maternal depression, children's maternal depression exposure, and paternal depression. As females show a preponderance of depression beginning in adolescence and some research suggests that differences in stress reactivity early in life may play a role (Kryski et al., 2013; Natsuaki et al., 2009), analyses were conducted to explore whether child sex moderated the effect of any of the major independent variables in predicting AUC_i and AUC_g or cortisol intercept, slope, or curvature in MLM. All non-significant interaction terms were dropped from final models to conserve power (Aiken & West, 1991). Child sex was also dropped from final models when no

⁴ Although chronic stress and parenting show some degree of heritability (Federenko et al., 2006; McGuire, 2003), based on previous theory and research, I elected to conceptualize these as environmental constructs in the present study. Further, these constructs are more readily modifiable than specific genes, and possibly parental depression.

significant sex interactions were found. Lastly, main effects of maternal and paternal depression recurrence and age of onset were explored in association with AUC_i and AUC_g as well as with cortisol intercept, slope, and curvature in MLM.

Bivariate Correlations

Table 3 presents the correlations between all major study variables. AUC_i and AUC_g were positively correlated with each other, as well as with cortisol levels at each time point with one exception: baseline cortisol was unrelated to AUC_i. Poor parenting was positively correlated with cortisol at 30- and 40-minutes post-stress. Poor parenting was significantly associated with higher rates of maternal depression, children's maternal depression exposure, and chronic family stress, as well as with lower child PPVT scores. Greater chronic family stress was significantly associated with higher AUC_i and AUC_g and cortisol at all time points with the exception of the final sample (50 minutes post-stress). In addition, higher chronic family stress was significantly associated with higher rates of maternal depression, children's maternal depression exposure, and maternal anxiety, as well as paternal depression. Higher chronic family stress was significantly associated with lower child PPVT scores and lower primary caregiver age. Child BDNF genotype was significantly correlated with cortisol at 10 minutes post-stress such that children with at least one copy of the met allele had lower cortisol immediately after the stressor. In addition, child BDNF genotype was significantly correlated with primary caregiver age. Maternal depression was associated with significantly higher rates of all other maternal and paternal disorder indices, with the exception of paternal anxiety. Children's maternal depression exposure was significantly associated with higher cortisol at 20 minutes post-stress and higher AUC_g. Maternal anxiety was significantly associated with higher AUC_i and lower primary caregiver age. Paternal depression was associated with significantly higher rates of paternal anxiety. Paternal anxiety

Table 3

Correlations among all major variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Baseline Cortisol	-													
2. Cortisol 10 minutes	.58**	-												
3. Cortisol 20 minutes	.47**	.71**	-											
4. Cortisol 30 minutes	.54**	.63**	.61**	-										
5. Cortisol 40 minutes	.55**	.56**	.65**	.72**	-									
6. Cortisol 50 minutes	.40**	.33**	.35**	.44**	.60**	-								
7. AUCg	.66**	.80**	.71**	.85**	.84**	.63**	-							
8. AUCi	.02	.59**	.83**	.67**	.67**	.48**	.75**	-						
9. Poor Parenting	.08	.05	.07	.09 [†]	.10 [†]	.06	.07	.05	-					
10. Chronic Family Stress	.11*	.21**	.18**	.11*	.10*	.06	.16**	.12*	.41**	-				
11. 5-HTTLPR	-.04	-.01	.02	-.03	-.02	-.08	-.05	-.03	-.05	-.02	-			
12. BDNF val66met	.03	-.10*	-.02	-.04	-.00	.00	-.04	-.07	-.04	-.09 [†]	-.02	-		
13. Mat. Depression	.08	.08	.08 [†]	.01	.04	-.01	.06	.01	.11*	.24**	.07	.06	-	
14. Children's Mat. Depression Exposure	.08	.09 [†]	.12*	.04	.06	-.01	.09 [†]	.04	.11*	.23**	-.01	.02	.75**	-
15. Mat. Anxiety	-.03	.08	.07	.06	.08	.01	.06	.11*	-.01	.22**	.07	-.08	.22**	.18**
16. Pat. Depression	.01	-.04	-.02	.06	.02	.02	.01	-.00	.06	.13*	-.04	.01	.03	.05
17. Pat. Anxiety	-.02	-.01	.06	.09 [†]	.07	.03	.07	.10 [†]	-.01	.08	-.06	.01	.05	.08
18. PPVT Scores	-.02	-.00	-.04	.04	.00	-.02	.02	.03	-.32**	-.11*	.03	-.08	-.05	.03
19. Child Sex	-.07	-.01	.02	-.01	.02	-.04	-.00	.05	-.04	.04	.07	-.01	-.04	-.04
20. Child Age	-.13**	-.07	.00	-.09 [†]	-.07	-.07	-.07	.02	-.08	-.07	-.07	.05	-.01	.06

(continued)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
21. Primary Caregiver Age ⁵	-.03	-.11*	-.04	-.15**	-.08	-.06	-.10 [†]	-.11*	-.10*	-.18**	-.06	.20**	-.03	-.01
22. Mat. Age	-.02	-.11*	-.03	-.13*	-.08	-.06	-.09 [†]	-.11*	-.10*	-.20**	-.04	.17**	-.02	-.01
23. Pat. Age	.05	-.06	.02	-.09 [†]	-.02	-.03	-.04	-.08	-.10*	-.11*	-.12*	.11*	-.03	-.03
Mean	.026	.037	.041	.037	.037	.036	.13	.23	.00	.00	-	-	-	-
SD	.017	.032	.041	.029	.035	.037	.09	.07	.92	2.05	-	-	-	-
	15	16	17	18	19	20	21	22	23					
16. Pat. Depression	.13*	-												
17. Pat. Anxiety	-.01	.21**	-											
18. PPVT Scores	.02	.09	-.01	-										
19. Child Sex	.02	.04	-.07	.07	-									
20. Child Age	-.04	-.03	-.05	.05	.07	-								
21. Primary Caregiver Age	-.10*	-.01	.01	.06	.01	.14**	-							
22. Mat. Age	-.10*	-.03	.02	.07	-.04	-.04	.95**	-						
23. Pat. Age	-.10 [†]	-.04	.06	.06	-.01	.13**	.75**	.72**	-					
Mean	-	-	-	112.00	-	3.44	34.00	33.25	35.01					
SD	-	-	-	14.04	-	.30	4.85	4.62	4.89					

[†] $p < .10$, * $p < .05$, ** $p < .01$; all correlations involving a dichotomous variable are point-biserial; cortisol levels are measured in micrograms per liter (ug/dl) and have been log10 transformed; Mat. = maternal; Pat. = paternal; child sex: male = 0 and female = 1; 5-HTTLPR: l/l = 0 and s/s or s/l = 1; BDNF val66met: val/val = 0 and val/met or met/met = 1; all parent psychopathology variables: disorder absent = 0 and disorder present = 1

⁵ Primary caregiver age was included as chronic family stress and parenting data were obtained from the child's primary caregiver.

was associated with higher cortisol at 30 minutes post-stress. Child age was significantly associated with lower baseline cortisol and greater caregiver age. Higher primary caregiver age was significantly associated with lower child cortisol at 10 and 30 minutes post-stress. Effects for maternal and paternal age were very similar for those for primary caregiver age, except for a lack of association between paternal age and cortisol at 10 minutes post-stress and AUC_i, and a significant negative correlation between paternal age and child 5-HTTLPR genotype.

Area Under the Curve Analyses

I tested 3 separate models predicting AUC_i and 3 models predicting AUC_g using IBM SPSS Statistics (IBM, 2012); to keep the number of variables in models acceptable for this sample size, analyses were organized based on the following variables, and will be presented accordingly: 1) maternal depression, 2) children's maternal depression exposure, and 3) paternal depression⁶. For testing interactions between biological and contextual variables, all moderation analyses were conducted using the procedures and macro described by Hayes and Matthes (2009). Interactions were probed by examining the conditional effects for two-way interactions between predictors (Aiken & West, 1991). When examining an interaction between a dichotomous moderator and a continuous focal predictor, the effect of the

⁶ Relatives of probands with early onset and recurrent forms of depression are at particularly high risk for depression (Klein, Lewinsohn, Rohde, Seeley, & Durbin, 2002; Sullivan, Neale, & Kendler, 2000). This suggests that dysregulated cortisol reactivity may be especially pronounced in the children of parents with early onset or recurrent forms of depression; I examined this possibility in secondary analyses. As previous studies have often used a cutoff of age 21 to distinguish early from late onset (Durbin, Klein, Hayden, Buckley, & Moerk, 2005; Olino, Klein, Dyson, Rose, & Durbin, 2010) I used this convention to create three-level early onset depression variables for maternal and paternal depression: 0 = no MDD; 1 = late onset (\geq age 21) MDD; 2 = early onset ($<$ age 21) MDD. I also created three-level variables for recurrent depression: 0 = no MDD; 1 = single episode; 2 = recurrent MDD. These variables were also created using data from the SCID. Models were run by substituting these variables for depression in the described AUC and MLM models containing main effects only. Thus, these models contained all the other biological and contextual predictors as the previous models. However, no significant main effects involving these parental depression variables were found for AUC_g, AUC_i, or MLM ($ps \geq .117$).

continuous focal variable was examined at each level of a dichotomous moderator (Aiken & West, 1991). In the case where both IVs in an interaction were dichotomous, the effect of the moderator was examined at each level of the dichotomous focal predictor (Aiken & West, 1991). The Johnson-Neyman technique was used to derive regions of significance (ROS) for the conditional effects of a moderator at varying levels of a continuous focal predictor (Aiken & West, 1991; Johnson & Neyman, 1936). ROS values were obtained using the procedures and macro described by Hayes and Matthes (2009). Used in this context, the Johnson-Neyman technique allows one to determine the level of the continuous focal predictor at which the conditional effect of the moderator reaches significance, and is used in conjunction with Aiken and West's procedures to fully probe all aspects of an interaction (Pedhazur, 1997).

Variables were entered into a multiple regression model by first entering primary caregiver age and parent (maternal or paternal) anxiety disorder, followed by child sex, BDNFval66met, 5-HTTLPR, chronic family stress, poor parenting, and parent (maternal or paternal) depression, followed by two-way interactions of interest⁷. The following interaction terms were created by first centering continuous predictors, then taking the product of the two terms: BDNF val66met X poor parenting, BDNF val66met X parent depression, BDNF val66met X chronic family stress, 5-HTTLPR X poor parenting, 5-HTTLPR X chronic family stress, 5-HTTLPR x parent depression, parent depression X poor parenting, parent depression X chronic family stress, child sex X BDNF val66met, child sex X 5-HTTLPR, child sex X parent depression, child sex X chronic family stress, and child sex X poor

⁷ As child PPVT scores, child age, and primary caregiver age were significantly associated with several other independent variables of interest, they were explored as potential covariates in initial models, then dropped when they did not contribute unique variance. Only primary caregiver age was found to predict unique variance in some models and was thus retained as a covariate in all analyses along with parent anxiety.

parenting. All non-significant interaction terms were dropped from final models to conserve power. When interactions were expected based on prior theory or research, these are noted; otherwise, these are not discussed.

Maternal depression and AUCi and AUCg.

AUCi. Child sex was dropped from the maternal depression model predicting AUCi, as it did not significantly predict AUCi and was not a primary IV of interest; no interactions predicted AUCi either, and were thus dropped as well. The final model therefore consisted solely of main effects, none of which was significant (see Table 4).

AUCg. The following interactions were dropped from the final model as they were not significant: BDNF val66met X poor parenting, BDNF val66met X maternal depression, BDNF val66met X chronic family stress, 5-HTTLPR X poor parenting, 5-HTTLPR X chronic family stress, 5-HTTLPR x maternal depression, child sex X BDNF val66met, child sex X 5-HTTLPR, child sex X maternal depression, child sex X chronic family stress, and child sex X poor parenting. Thus, in contrast to previous research (e.g., Alexander et al., 2009; Hayden et al., 2010) I did not find a significant interaction between 5-HTTLPR or BDNF and life stress (chronic family stress or poor parenting) in association with cortisol reactivity, nor were other gene-environment interactions found. Child sex was also dropped as it did not significantly predict AUCg, nor were any sex interactions significant.

The final model for AUCg can be found in Table 5. There were no significant main effects of BDNF, 5-HTTLPR, poor parenting, or maternal depression. Chronic family stress was associated with significantly higher AUCg; however, the main effect of chronic family stress was qualified by a significant interaction with maternal depression. Specifically, higher chronic family stress was associated with significantly higher AUCg only in children with a history of maternal depression, $b = .02$, $t(368) = 2.87$, $p < .01$ (see Figure 1). Children with

Table 4

Maternal depression and other factors predicting children's area under the curve with respect to increase

Variable	Overall Model				
	<i>df</i>	<i>R</i> ²	<i>F</i>	ΔR^2	<i>b</i>
	7,369	.033	1.824 [†]		
Primary Caregiver age					-.001
Maternal Anxiety					.017 [†]
BDNF Val66met					-.004
5-HTTLPR					-.005
Chronic Family Stress					.003
Poor Parenting					.000
Maternal Depression					-.005

[†] $p < .10$, $*p < .05$, 5-HTTLPR: l/l = 0 and s/s or s/l = 1; BDNF val66met: val/val = 0 and val/met or met/met = 1; both depression and anxiety were coded as 0 = no lifetime history of disorder, 1 = lifetime history of disorder.

Table 5

Maternal depression and other factors predicting children's area under the curve with respect to ground

Variable	Overall Model				
	<i>df</i>	<i>R</i> ²	<i>F</i>	ΔR^2	<i>b</i>
Step 1	7,369	.030	1.604		
Primary Caregiver age					-.001
Maternal Anxiety					.007
BDNF Val66met					-.003
5-HTTLPR					-.013
Chronic Family Stress					.006*
Poor Parenting					-.001
Maternal Depression					.004
Step 2	9,367	.051	2.185*	.021	
Primary Caregiver age					-.001
Maternal Anxiety					.004
BDNF Val66met					-.003
5-HTTLPR					-.016
Chronic Family Stress					.002
Poor Parenting					.009
Maternal Depression					.002
Maternal Depression X Chronic Family Stress					.013*
Maternal Depression X Poor Parenting					-.033**

* $p < .05$, ** $p < .01$; 5-HTTLPR: l/l = 0 and s/s or s/l = 1; BDNF val66met: val/val = 0 and val/met or met/met = 1; both depression and anxiety were coded as 0 = no lifetime history of disorder, 1 = lifetime history of disorder.

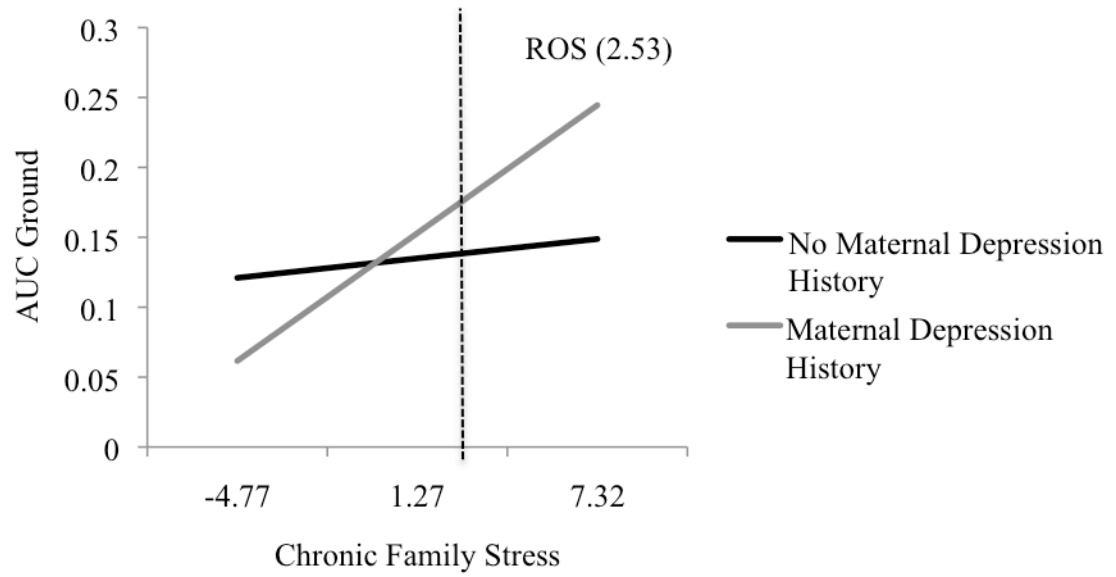


Figure 1. The association between chronic family stress and children's cortisol area under the curve with respect to ground (AUC Ground) as a function of maternal depression history.

ROS = Region of Significance.

and without a maternal depression history differed significantly in AUC_g at high levels of chronic family stress (> 1SD above the mean), specifically at values > 2.53; thus, chronic family stress only needed to be slightly higher than average in our sample for the difference in AUC_g between children with and without maternal depression to become significant.

An interaction was also found between maternal depression and poor parenting in predicting AUC_g, such that poorer parenting was associated with significantly lower AUC_g only in children with a maternal depression history, $b = -.02$, $t(368) = -2.29$, $p = .02$ (see Figure 2). Children with and without a maternal depression history differed significantly in AUC_g at both low and high levels (> 1SD below and above the mean) of poor parenting, specifically at values of poor parenting < -1.01 and > 1.16; thus, poor parenting only needed to be slightly below or above average levels of poor parenting in the sample for these effects to be seen.

Children's maternal depression exposure and AUC_i and AUC_g. To further disentangle the effects of exposure to maternal depression on cortisol reactivity, the effect of children's maternal depression exposure was also explored. This was done by substituting the variable contrasting maternal depression occurring during the child's lifetime to no maternal depression or episodes occurring prior to the child's birth for the maternal lifetime depression variable (and associated interaction terms).

AUC_i. The following interactions were dropped from the final model as they were not significant: BDNF val66met X poor parenting, BDNF val66met X children's maternal depression exposure, BDNF val66met X chronic family stress, 5-HTTLPR X poor parenting, 5-HTTLPR X chronic family stress, 5-HTTLPR x children's maternal depression exposure, children's maternal depression exposure X poor parenting, children's maternal depression exposure X chronic family stress, child sex X BDNF val66met, child sex X 5-HTTLPR,

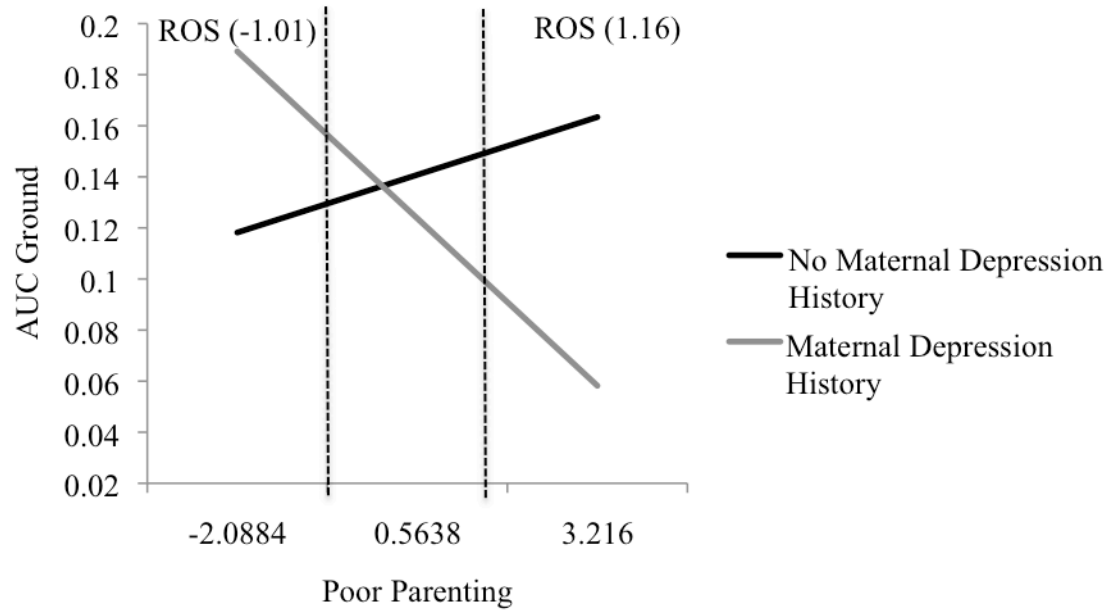


Figure 2. The association between poor parenting and children's cortisol area under the curve with respect to ground (AUC Ground) as a function of maternal depression history. ROS = Region of Significance.

child sex X chronic family stress, and child sex X poor parenting. As with maternal depression models and contrary to previous research, I did not find significant interactions between 5-HTTLPR genotype and life stress, or BDNF genotype and life stress (e.g., Alexander et al., 2009; Hayden et al., 2010), nor were any other gene-environment interactions found.

The final model summary can be found in Table 6. No significant main effects were found, although a significant interaction between child sex and children's maternal depression exposure was obtained. Specifically, a significant effect of child sex on AUC_i was found only for children exposed to maternal depression during their lifetime $b = .04$, $t(369) = 2.34$, $p = .02$, showing higher cortisol reactivity in girls relative to boys (*ns* for children without maternal depression exposure; see Figure 3). Children with maternal depression exposure did not differ significantly from children with no maternal depression exposure, nor did boys and girls without maternal depression exposure differ from each other.

AUC_g. The following interactions were dropped from the final model as they were not significant: BDNF val66met X poor parenting, BDNF val66met X children's maternal depression exposure, BDNF val66met X chronic family stress, 5-HTTLPR X poor parenting, 5-HTTLPR X chronic family stress, 5-HTTLPR x children's maternal depression exposure, children's maternal depression exposure X chronic family stress, child sex X BDNF val66met, child sex X 5-HTTLPR, child sex X chronic family stress, and child sex X poor parenting; thus, no gene-environment interactions were found in predicting AUC_g in this model, in contrast to past work (e.g., Alexander et al., 2009; Hayden et al., 2010). Child sex was also dropped from this model as it was not significantly associated with AUC_g, nor were any interactions between sex and other study variables significant.

Table 6

Children's maternal depression exposure and other factors predicting children's area under the curve with respect to increase

Variable	Overall Model				
	<i>df</i>	<i>R</i> ²	<i>F</i>	ΔR^2	<i>b</i>
Step 1	8,369	.035	1.656		
Primary Caregiver age					-.001 [†]
Maternal Anxiety					.015 [†]
Child Sex					.005
BDNF Val66met					-.005
5-HTTLPR					-.006
Chronic Family Stress					.002
Poor Parenting					-.000
Children's Maternal Depression Exposure					.001
Step 2	9,368	.048	2.077*	.013	
Primary Caregiver age					-.001
Maternal Anxiety					.012
Child Sex					-.002
BDNF Val66met					-.004
5-HTTLPR					-.004
Chronic Family Stress					.003
Poor Parenting					.000
Children's Maternal Depression Exposure					-.018
Child Sex X Children's Maternal Depression Exposure					.043*

[†]*p* < .10, **p* < .05; child sex: males = 0 and females = 1; 5-HTTLPR: l/l = 0 and s/s or s/l = 1;

BDNF val66met: val/val = 0 and val/met or met/met = 1; both depression and anxiety were coded as 0 = no child exposure/lifetime disorder, 1 = child exposure/lifetime disorder.

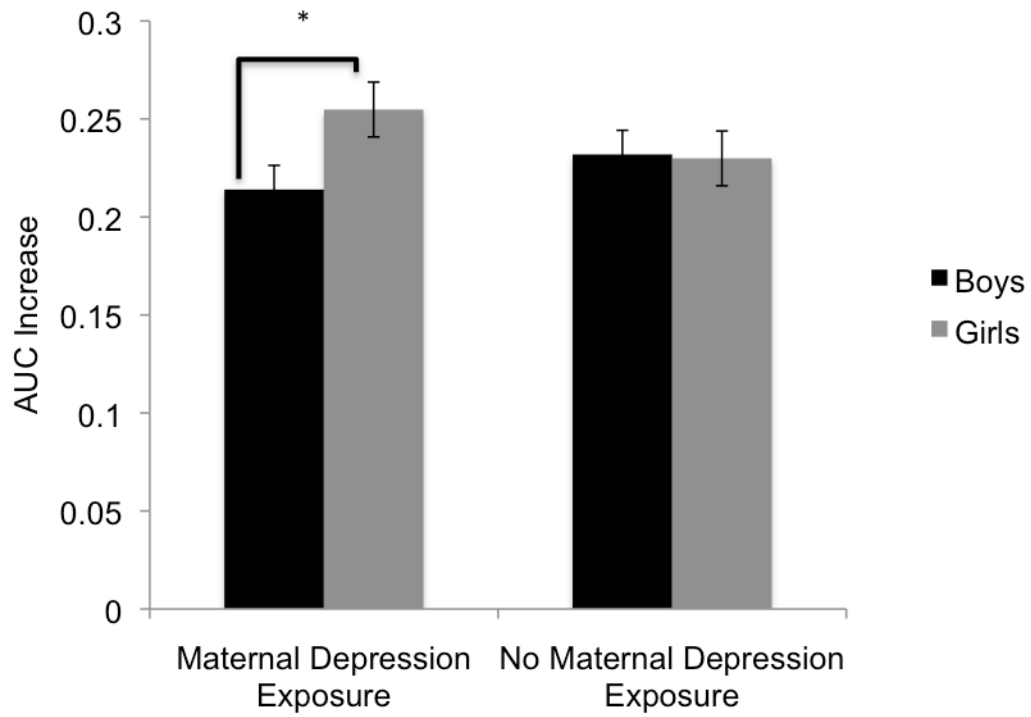


Figure 3. The association between child sex and children cortisol area under the curve with respect to increase (AUC Increase) as a function of children's maternal depression exposure.

* $p < .05$

The final model summary can be found in Table 7. No significant main effects were found. A significant interaction was found between children's maternal depression exposure and poor parenting in association with AUCg (Figure 4), such that poorer parenting was associated with significantly lower AUCg only in children who were exposed to maternal depression during their lifetime $b = -.03$, $t(368) = -2.14$, $p = .03$, (*ns* for children with no exposure). Children with and without exposure to maternal depression differed significantly in AUCg at high levels of poor parenting ($> 1SD$ above the mean), specifically values of poor parenting > 1.43 ; thus, parenting only needed to be slightly poorer than average for this sample for this effect to be seen.

Paternal depression and AUCi and AUCg.

AUCi. The following interactions were dropped from the final model as they were not significant: BDNF val66met X poor parenting, BDNF val66met X paternal depression, BDNF val66met X chronic family stress, 5-HTTLPR X poor parenting, 5-HTTLPR X chronic family stress, 5-HTTLPR x paternal depression, paternal depression X poor parenting, paternal depression X chronic family stress, child sex X BDNF val66met, child sex X 5-HTTLPR, child sex X chronic family stress, and child sex X poor parenting. Once again, in contrast to previous research (e.g., Alexander et al., 2009; Hayden et al., 2010), I did not find an interaction between 5-HTTLPR or BDNF genotypes and life stress (chronic family stress or poor parenting) in association with cortisol reactivity as indexed by AUCi.

The final model summary can be found in Table 8. Paternal anxiety was associated with significantly higher AUCi; no other main effects reached significance. An interaction was found between child sex and paternal depression such that girls with a history of paternal depression had significantly lower AUCi than girls with no paternal depression, $b = -.03$, $t(325) = -2.33$, $p = .02$ (see Figure 5), and were also significantly lower than boys with a

Table 7

Children's maternal depression exposure and other factors predicting children's area under the curve with respect to ground

Variable	Overall Model				
	<i>df</i>	<i>R</i> ²	<i>F</i>	ΔR^2	<i>b</i>
Step 1	7,370	.033	1.781 [†]		
Primary Caregiver age					-.001
Maternal Anxiety					.006
BDNF Val66met					-.004
5-HTTLPR					-.012
Chronic Family Stress					.005 [†]
Poor Parenting					-.001
Children's Maternal Depression Exposure					.014
Step 2	8,369	.047	2.300*	.014	
Primary Caregiver age					-.001
Maternal Anxiety					.001
BDNF Val66met					-.005
5-HTTLPR					-.012
Chronic Family Stress					.005
Poor Parenting					.005
Children's Maternal Depression Exposure					.020
Children's Maternal Depression Exposure X Poor Parenting					-.034*

[†]*p* < .10, **p* < .05; child sex: males = 0 and females = 1; 5-HTTLPR: l/l = 0 and s/s or s/l = 1;

BDNF val66met: val/val = 0 and val/met or met/met = 1; both depression and anxiety were

coded as 0 = no child exposure/lifetime disorder, 1 = child exposure/lifetime disorder.

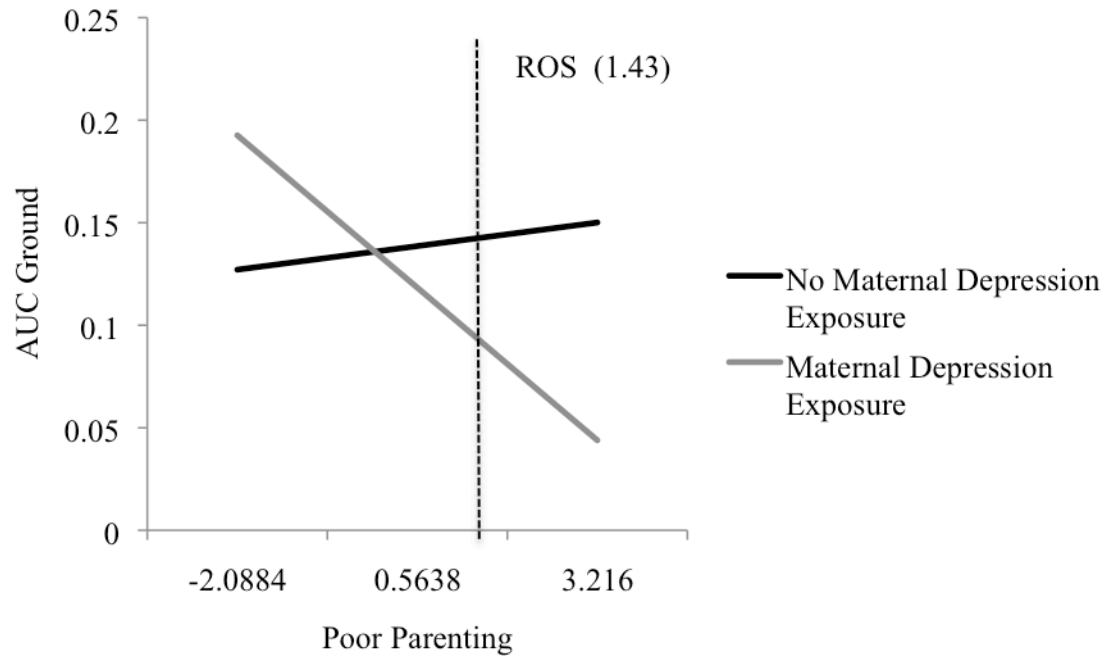


Figure 4. The association between poor parenting and children’s cortisol area under the curve with respect to ground (AUC Ground) as a function of children’s maternal depression exposure. ROS = Region of Significance.

Table 8

Paternal depression and other factors predicting children's area under the curve with respect to increase

Variable	Overall Model				
	<i>df</i>	<i>R</i> ²	<i>F</i>	ΔR^2	<i>b</i>
Step 1	8,326	.036	1.520		
Primary Caregiver age					-.001 [†]
Paternal Anxiety					.021 [†]
Child Sex					.002
BDNF Val66met					-.004
5-HTTLPR					-.008
Chronic Family Stress					.002
Poor Parenting					.002
Paternal Depression					-.007
Step 2	9,325	.057	2.181*	.021	
Primary Caregiver age					-.001 [†]
Paternal Anxiety					.017
Child Sex					.008
BDNF Val66met					-.004
5-HTTLPR					-.009
Chronic Family Stress					.002
Poor Parenting					.002
Paternal Depression					.021
Child Sex X Paternal Depression					-.052**

[†]*p* < .10, ***p* < .01; child sex: male = 0 and female = 1; 5-HTTLPR: l/l = 0 and s/s or s/l = 1;

BDNF val66met: val/val = 0 and val/met or met/met = 1; both depression and anxiety were coded as 0 = no lifetime history of disorder, 1 = lifetime history of disorder.

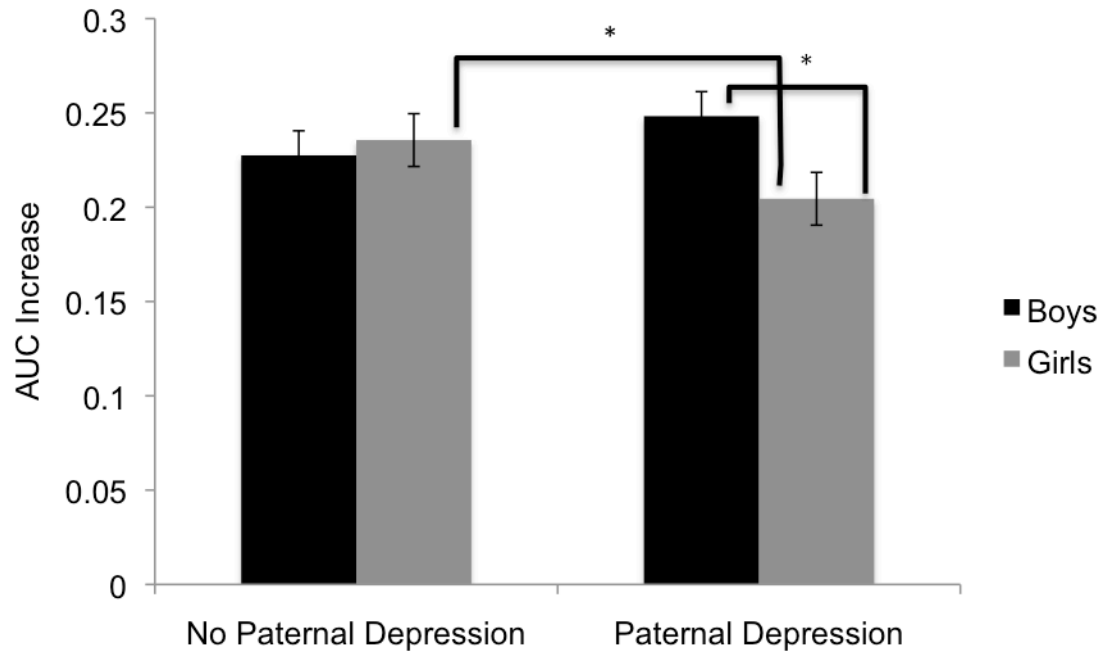


Figure 5. The association between child sex and children's cortisol area under the curve with respect to increase (AUC Increase) as a function of paternal depression history. * $p < .05$

paternal history of depression, $b = -.04$, $t(325) = -2.41$, $p = .02$. There was no effect of child sex for children with no paternal depression history, nor did boys differ significantly from one another depending on whether they had a paternal history of depression.

AUCg. The following interactions were dropped from the final model as they were not significant: BDNF val66met X poor parenting, BDNF val66met X paternal depression, BDNF val66met X chronic family stress, 5-HTTLPR X poor parenting, 5-HTTLPR X chronic family stress, paternal depression X poor parenting, paternal depression X chronic family stress, child sex X BDNF val66met, child sex X 5-HTTLPR, child sex X paternal depression, child sex X chronic family stress, and child sex X poor parenting. No interactions between BDNF and contextual variables were found, in contrast to prior work (Hayden et al., 2010; Hosang et al., 2014). Child sex was also dropped from this model because it did not significantly predict *AUCg* and no sex interactions reached significance.

The final model summary can be found in Table 9. A main effect of chronic family stress was found, indicating higher *AUCg* with higher levels of chronic stress. A main effect of 5-HTTLPR genotype was also found in this model, such that carrying a s allele was associated with significantly lower *AUCg*; however, this effect was qualified by a significant interaction with paternal depression (see Figure 6). A significant effect of 5-HTTLPR genotype on *AUCg* was found for children with no history of paternal depression, $b = -.03$, $t(325) = -3.04$, $p = .00$ (*ns* for children with a history of paternal depression), indicating higher *AUCg* in children homozygous for the l allele. Additionally, there was a significant effect of paternal depression on *AUCg* only in l homozygotes, $b = -.05$, $t(368) = -2.12$, $p = .03$, (*ns* for children carrying at least one s allele), indicating significantly higher cortisol in children with a paternal depression history.

Table 9

Paternal depression and other factors predicting children's area under the curve with respect to ground

Variable	Overall Model				
	<i>df</i>	<i>R</i> ²	<i>F</i>	ΔR^2	<i>b</i>
Step 1	7,327	.047	2.302*		
Primary Caregiver age					-.002
Paternal Anxiety					.016
BDNF Val66met					-.001
5-HTTLPR					-.024*
Chronic Family Stress					.006*
Poor Parenting					-.001
Paternal Depression					-.009
Step 2	8,326	.060	2.622**	.013	
Primary Caregiver age					-.002
Paternal Anxiety					.024
BDNF Val66met					-.002
5-HTTLPR					-.033**
Chronic Family Stress					.005
Poor Parenting					-.001
Paternal Depression					-.052*
5-HTTLPR X Paternal Depression					.064*

* $p < .05$, ** $p < .01$; 5-HTTLPR: l/l = 0 and s/s or s/l = 1; BDNF val66met: val/val = 0 and

val/met or met/met = 1; both depression and anxiety were coded as 0 = no lifetime history of disorder, 1 = lifetime history of disorder.

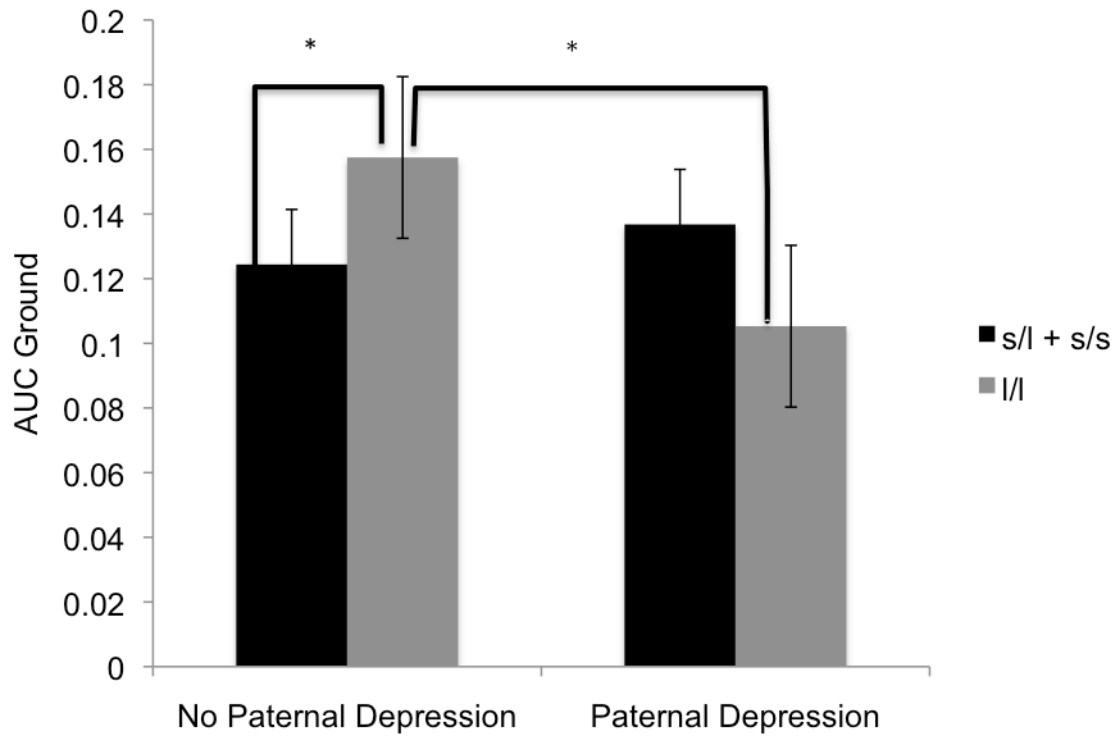


Figure 6. The association between 5-HTTLPR genotype and children's cortisol area under the curve with respect to ground (AUC Ground) as a function of paternal depression history.

* $p < .05$

Multi-level Modeling Analyses

I next analyzed predictors of children's cortisol reactivity to stress using multi-level modeling (MLM) conducted in the HLM statistical program version 7 (SSI Inc., Lincolnwood, IL). MLM allows the data to be modeled at two levels (Level 1, which captures within-individual change over time, and Level 2, which allows one to test predictors of any interindividual differences in change (Singer & Willett, 2003). For this study, Level 1 consisted of cortisol time points (baseline, 10, 20, 30, 40, and 50 minutes) while Level 2 was individual children and consisted of the individual measures. On the second level, I estimated equations to predict differences in Level 1 intercepts (baseline cortisol), instantaneous rate of change (hereby referred to as "slope"), and curvature from the following Level 2 predictors (primary caregiver age, parent anxiety, child sex, 5-HTLPR and BDNF val66met genotypes, poor parenting, chronic family stress, parent depression, and relevant two-way interactions). Two adjustments were made to the data to ease interpretation of the results: First, time was anchored at baseline (at baseline, time = 0) so that the cortisol intercepts (β_{00}) would reflect the average individual's cortisol level at baseline; and second, all Level 2 between-person variables were centered at their grand mean.

These models can be understood as a within-subjects regression of an individual's cortisol values onto the time of each assessment. To evaluate these models, the following function was specified to describe the data from each individual:

$$\text{Level 1: } Y_{ij} = \beta_{0j} + \beta_{1j}(\text{Time}) + \beta_{2j}(\text{Time}^2) + r_{ij}$$

Level 2

$$\text{Intercept: } \beta_{0j} = \gamma_{00} + u_{0j}$$

$$\text{Slope: } \beta_{1j} = \gamma_{10} + u_{1j}$$

$$\text{Curvature: } \beta_{2j} = \gamma_{20} + u_{2j}$$

Equation 3

where Y_{ij} is the cortisol value of individual j at time i ; β_{0j} is the cortisol value of individual j at Time 0, (i.e., the baseline cortisol value of individual j); β_{1j} is the rate of the linear change in cortisol for individual j over the course of the home visit; β_{2j} is the rate of the curvature in cortisol; and r_{ij} is the residual variance in repeated measurements for individual j , assumed to be independent and normally distributed across subjects. Cortisol data were log 10 transformed prior to all analyses to remove a positive skew, a standard procedure with cortisol data (Gunnar & Talge, 2008). As measures were taken during data collection to obtain an accurate baseline cortisol sample by minimizing potential confounds (e.g., time of day, activity level, novel experimenter, etc.) and eliminating the well-established laboratory effect on cortisol (Gunnar & Talge, 2008), it is reasonable to assume that cortisol intercept in these MLM analyses can be described as indexing *resting* or *baseline* cortisol. In contrast, cortisol *slope* and *curvature* can be identified as the reactivity components of the model and will thus be referred to as such throughout.

Figure 7 shows the unconditional model. Overall, children demonstrated an increase in cortisol from baseline to 30 minutes post-stress followed by a subsequent decline. Confirming the selection of a quadratic model, a chi-square test of the deviance statistics between unconditional linear and quadratic models indicated that adding a quadratic term to the model resulted in a significant improvement in model fit, $X^2(1) = 550.31, p < .001$. Tests of unconditional models showed significant variation in intercept, slope, and curvature, confirming the appropriateness of testing Level 2 predictors of change ($ps < .001$; Singer & Willett, 2003).

Three MLM interaction models were run examining the effects of: 1) maternal lifetime depression, 2) children's maternal depression exposure, and 3) paternal lifetime depression.

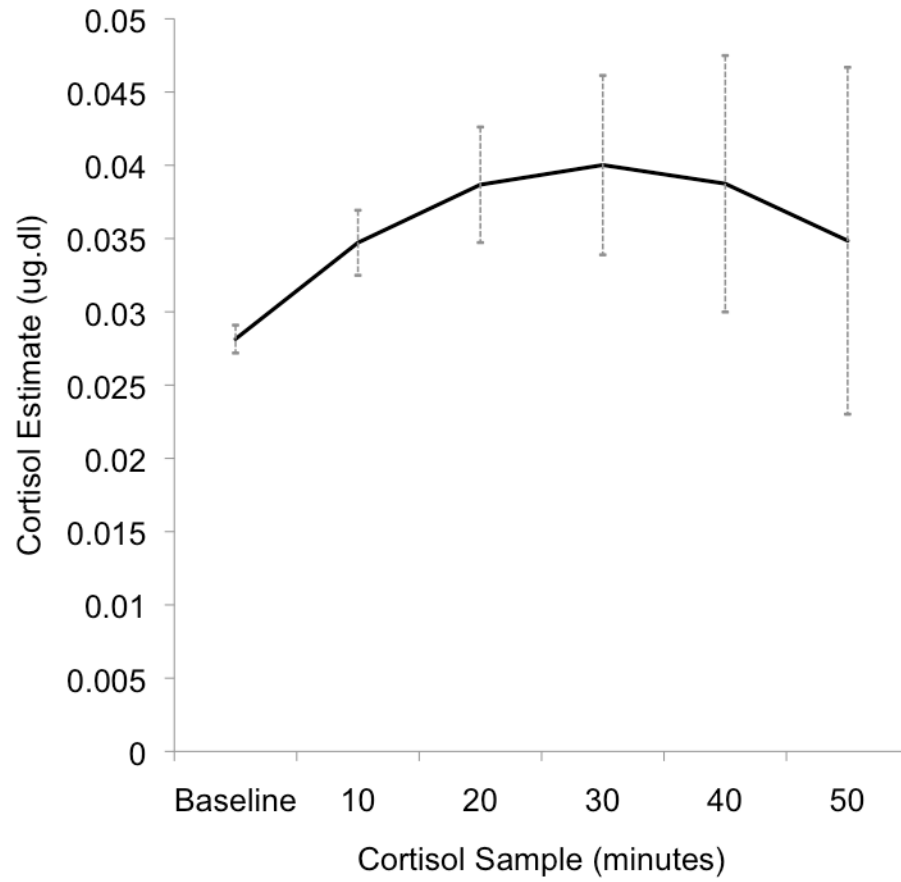


Figure 7. Unconditional quadratic model of the cortisol trajectory in multi-level modelling with standard error of the estimate.

Main effects and interactions were tested by entering all IVs and interaction terms at Level 2 of the model, and allowing them to predict cortisol intercept, slope, and curvature. The following interaction terms were created by first centering continuous predictors, then taking the product of the two terms: BDNF val66met X poor parenting, BDNF val66met X parent depression, BDNF val66met X chronic family stress, 5-HTTLPR X poor parenting, 5-HTTLPR X chronic family stress, 5-HTTLPR x parent depression, parent depression X poor parenting, parent depression X chronic family stress, child sex X BDNF val66met, child sex X 5-HTTLPR, child sex X parent depression, child sex X chronic family stress, and child sex X poor parenting. As with AUC analyses, non-significant interaction terms were dropped to conserve power. Child sex was also dropped from models in which there were no significant interactions between child sex and the primary IVs of interest.

Significant interactions were probed using procedures outlined by Aiken and West for use in multiple regression (1991); these procedures are also appropriate for MLM as an extension of standard multiple regression (Curran, Bauer, & Willoughby, 2006). Specifically, I examined the conditional effects of the focal predictor at each level of the moderator (simple slopes; Aiken & West, 1991). For dichotomous moderators (e.g., maternal depression), this was accomplished by reverse-coding the dichotomous moderator, recreating the interaction terms, and re-running the model, which allows one to view the effect of the focal predictor at different levels of the moderator. For continuous moderators, this was done by recentering the continuous moderator at values 1 SD above and below the mean, recreating the interaction terms, and rerunning the model. In doing so, one can examine the effect of the focal predictor at low and high levels of the moderator. Lastly, as MLM incorporates interactions with time, time is held constant while Level 2 variables are allowed

to vary; thus, in order to fully dismantle the interaction, the effect of the original moderator must then be examined at various levels of the focal predictor using the same recentering procedures described above (Aiken & West, 1991).

Maternal depression and cortisol intercept, slope, and curvature. The following interactions were dropped from the final model as they were not significant: BDNF val66met X poor parenting, BDNF val66met X maternal depression, BDNF val66met X chronic family stress, 5-HTTLPR X poor parenting, 5-HTTLPR X chronic family stress, 5-HTTLPR x maternal depression, child sex X BDNF val66met, child sex X 5-HTTLPR, child sex X maternal depression, child sex X chronic family stress, and child sex X poor parenting. In contrast to previous research finding interactions predicting related outcomes (Alexander et al., 2009; Hayden et al., 2010; Hosang et al., 2014), no interactions were found between 5-HTTLPR or BDNF val66met and life stress in association with cortisol intercept, slope, or curvature. Child sex was dropped from the final model as it did not significantly predict cortisol intercept, slope, or curvature, and no sex interactions reached significance.

The final model can be found in Table 10. No significant main effects were found. However, an interaction was found in which maternal depression interacted with poor parenting to significantly predict cortisol intercept and curvature (see Figure 8). Maternal depression was associated with a significantly higher cortisol intercept at low levels of poor parenting, *unstandardized intercept coefficient* = .008, *SE* = .004, $t(368) = 2.114$, $p = .035$. For children with a history of maternal depression, poorer parenting was associated with a significantly faster rate of quadratic growth, *unstandardized curvature coefficient* = .001, *SE* = .000, $t(368) = 2.065$, $p = .040$, indicating that children exposed to poorer parenting had a greater immediate decline in cortisol from 10-20 minutes post-stress than children exposed to low levels of poor parenting.

Table 10

Maternal depression and other factors predicting children's cortisol intercept, slope, and curvature in multi-level modeling

Fixed Effect	Coefficient (SE)	t-value	Variance component (SD)	Chi-squared test of variance
Cortisol intercept				
Intercept	.028(.001)	29.023***	.000(.013)	459.503***
Primary Caregiver Age	-.000(.000)	-.167		
Maternal Anxiety	-.003(.003)	-1.204		
BDNF val66met	-.001(.002)	-.466		
5-HTTLPR	-.002(.002)	-.852		
Chronic Family Stress	.001(.001)	1.682 [†]		
Poor Parenting	.001(.001)	.507		
Maternal Depression	.003(.002)	1.345		
Maternal Depression X Chronic Family Stress	.001(.001)	.507		
Maternal Depression X Poor Parenting	-.005(.003)	-2.076*		
Cortisol slope				
Intercept	.008(.001)	7.814***	.000(.016)	632.600***
Primary Caregiver Age	-.000(.000)	-1.033		
Maternal Anxiety	.005(.003)	1.447		
BDNF val66met	-.001(.002)	-.427		
5-HTTLPR	.001(.002)	.365		
Chronic Family Stress	.000(.001)	.095		
Poor Parenting	.002(.002)	1.038		
Maternal Depression	-.001(.002)	-.282		
Maternal Depression X Chronic Family Stress	.003(.002)	1.809 [†]		
Maternal Depression X Poor Parenting	-.006(.003)	-1.928 [†]		

(continued)

Cortisol curvature

Intercept	-.001(.000)	-5.697***	.000(.004)	816.370***
Primary Caregiver Age	.000(.000)	.729		
Maternal Anxiety	-.001(.001)	-1.155		
BDNF val66met	.000(.001)	.701		
5-HTTLPR	-.000(.001)	-.720		
Chronic Family Stress	-.000(.000)	-.429		
Poor Parenting	-.000(.000)	-.609		
Maternal Depression	-.000(.001)	-.224		
Maternal Depression X Chronic Family Stress	-.001(.001)	-1.721 [†]		
Maternal Depression X Poor Parenting	.001(.001)	2.027*		

[†] $p < .10$, * $p < .05$, *** $p < .001$; 5-HTTLPR: l/l = 0 and s/s or s/l = 1; BDNF val66met:

val/val = 0 and val/met or met/met = 1; both depression and anxiety were coded as 0 = no

lifetime history of disorder, 1 = lifetime history of disorder.

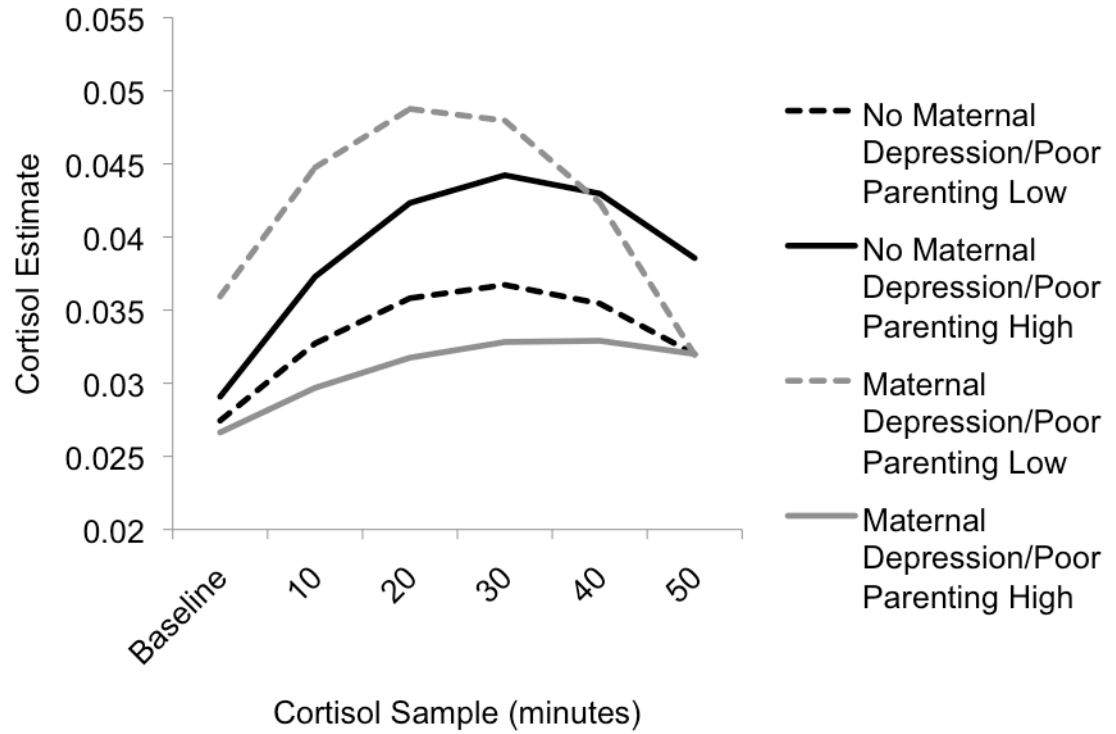


Figure 8. The association between poor parenting and cortisol intercept, slope, and curvature as a function of maternal depression history.

Examination of the cortisol trajectories estimated in Figure 8 suggested that children with a history of maternal depression who are exposed to high levels of poor parenting display a slow and steady increase in cortisol post-stress. To test this possibility, which requires looking at variation in intercept and slope at a specific time point, I recentered time at the fifth cortisol sample (taken at 40 minutes post-stress) by recoding the Level 1 variable *time* from “0, 1, 2, 3, 4, 5”, to “-4, -3, -2, -1, 0, 1” and examining the slope coefficients in the linear model, which now reflect cortisol slope at the new zero time point (Kryski et al., 2013b). In this model, there was a trend level effect of poor parenting on cortisol slope for children with a history of maternal depression, suggesting a higher cortisol slope (trend level) with higher levels of poor parenting, *unstandardized slope coefficient* = .001, *SE* = .001, $t(369) = 1.753, p = .080$. This effect was not seen when time was centered at the baseline sample and suggests that there is delay in recovery in children with a history of maternal depression who are exposed to high levels of poor parenting. There was no effect of poor parenting on cortisol slope for children with no maternal depression at this time point.

Children’s maternal depression exposure and cortisol intercept, slope, and curvature.

Effects of children’s maternal depression exposure on cortisol intercept, slope, and curvature were also explored by substituting the variable contrasting maternal depression occurring during the child’s lifetime to no maternal depression or episodes occurring prior to the child’s birth, for the maternal depression variable and its interactions terms in the preceding model. The following interactions were dropped from the final model as they were not significant: BDNF val66met X poor parenting, BDNF val66met X children’s maternal depression exposure, BDNF val66met X chronic family stress, 5-HTTLPR X poor parenting, 5-HTTLPR X chronic family stress, 5-HTTLPR x children’s maternal depression exposure, children’s maternal depression exposure X chronic family stress, child sex X BDNF

val66met, child sex X 5-HTTLPR, child sex X children's maternal depression exposure, child sex X chronic family stress, and child sex X poor parenting. Once again, no interactions were found between 5-HTTLPR or BDNF val66met and life stress in association with cortisol intercept, slope, or curvature (Alexander et al., 2009; Hayden et al., 2010; Hosang et al., 2014). Child sex was also dropped as it did not significantly predict cortisol intercept, slope, or curvature, and no sex interactions reached significance.

The final model, which yielded results highly similar to those found in the model using maternal lifetime depression, can be found in Table 11. Higher chronic family stress was associated with a significantly higher cortisol intercept. Children's maternal depression exposure interacted with poor parenting to significantly predict cortisol intercept and curvature (Figure 9). For children exposed to maternal depression during their life, poorer parenting was associated with a significantly lower cortisol intercept, *unstandardized intercept coefficient* = -.008, *SE* = .003, $t(369) = -2.888$, $p = .004$. In addition, at low levels of poor parenting, exposure to maternal depression was associated with a significantly higher cortisol intercept, *unstandardized intercept coefficient* = .012, *SE* = .005, $t(369) = 2.616$, $p = .009$. With regard to cortisol curvature, for children exposed to maternal depression, poorer parenting was associated with a significantly faster rate of quadratic growth, *unstandardized curvature coefficient* = .001, *SE* = .001, $t(369) = 2.027$, $p = .043$. At low levels of poor parenting, exposure to maternal depression was associated with slower rate of quadratic growth, *unstandardized curvature coefficient* = -.002, *SE* = .001, $t(369) = -2.110$, $p = .036$.

Paternal depression and cortisol intercept, slope, and curvature. The following interactions were dropped from the final model as they were not significant: BDNF val66met X poor parenting, BDNF val66met X paternal depression, BDNF val66met X chronic family stress, 5-HTTLPR X poor parenting, paternal depression X poor parenting, paternal

Table 11

Children's maternal depression exposure and other factors predicting children's cortisol intercept, slope, and curvature in multi-level modeling

Fixed Effect	Coefficient (SE)	t-value	Variance component (SD)	Chi-squared test of variance
Cortisol intercept				
Intercept	.028(.001)	29.103***	.000(.013)	456.620**
Primary Caregiver Age	-.000(.000)	-.142		
Maternal Anxiety	-.004(.003)	-1.408		
BDNF val66met	-.001(.002)	-.538		
5-HTTLPR	-.002(.002)	-.824		
Chronic Family Stress	.002(.001)	2.369*		
Poor Parenting	.001(.001)	.609		
Children's Maternal Depression Exposure	.004(.003)	1.524		
Children's Maternal Depression Exposure X Poor Parenting	-.008(.003)	-2.924**		
Cortisol slope				
Intercept	.008(.001)	7.466***	.000(.016)	640.050***
Primary Caregiver Age	-.000(.000)	-.892		
Maternal Anxiety	.004(.003)	1.172		
BDNF val66met	-.001(.002)	-.608		
5-HTTLPR	.002(.002)	.740		
Chronic Family Stress	.001(.001)	1.206		
Poor Parenting	.001(.002)	.575		
Children's Maternal Depression Exposure	.004(.004)	1.080		
Children's Maternal Depression Exposure X Poor Parenting	-.004(.003)	-1.632		
Cortisol curvature				
Intercept	-.001(.000)	-5.683***	.000(.004)	820.579***

(continued)

Primary Caregiver Age	.000(.000)	.622
Maternal Anxiety	-.001(.001)	-.855
BDNF val66met	.000(.000)	.860
5-HTTLPR	-.001(.001)	-1.042
Chronic Family Stress	-.000(.000)	-1.466
Poor Parenting	-.000(.000)	-.260
Children's Maternal Depression Exposure	-.001(.001)	-1.442
Children's Maternal Depression Exposure X Poor Parenting	.001(.001)	2.152*

* $p < .05$, ** $p < .01$, *** $p < .001$; 5-HTTLPR: l/l = 0 and s/s or s/l = 1; BDNF val66met:

val/val = 0 and val/met or met/met = 1; both depression and anxiety were coded as 0 = no child exposure/lifetime exposure and 1 = child exposure/lifetime disorder.

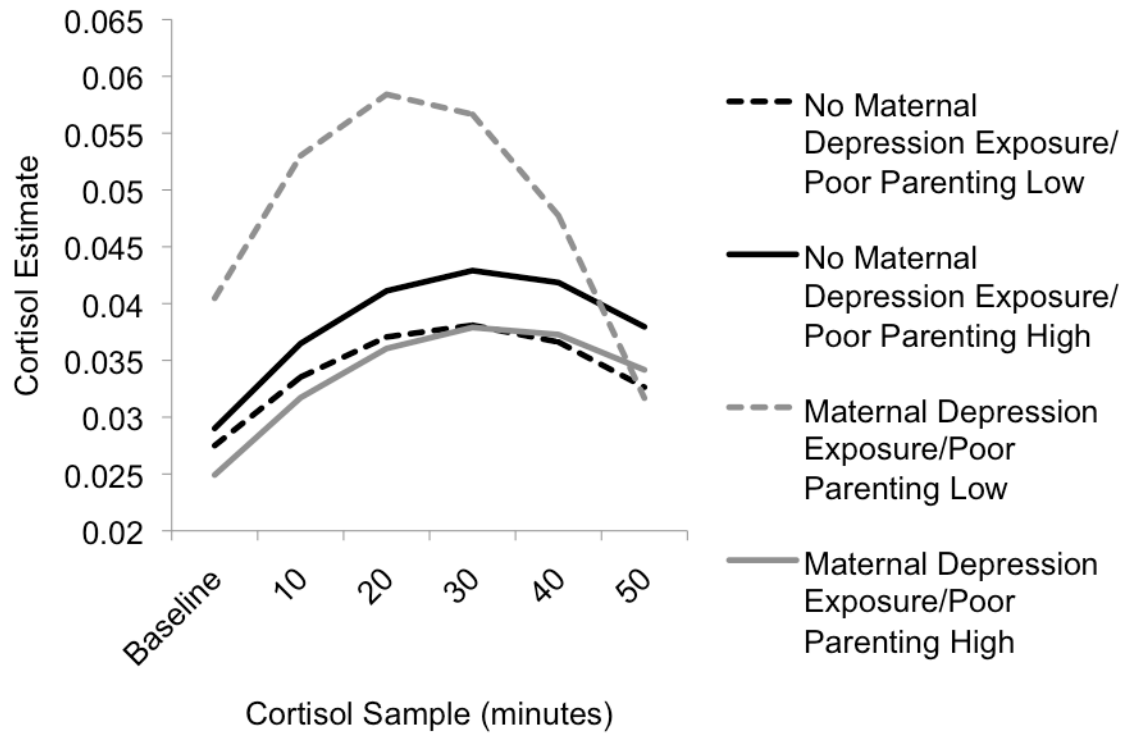


Figure 9. The association between poor parenting and cortisol intercept, slope, and curvature as a function of children's maternal depression exposure.

depression X chronic family stress, child sex X BDNF val66met, child sex X 5-HTTLPR, child sex X paternal depression, and child sex X chronic family stress. In contrast to previous literature, no interactions were found between BDNF val66met and life stress in association with cortisol intercept, slope, or curvature (Hayden et al., 2010; Hosang et al., 2014). The final model can be found in Table 12. Main effects were found in which paternal anxiety was associated with a significantly higher cortisol slope and slower rate of quadratic growth. Main effects of 5-HTTLPR genotype, chronic family stress, poor parenting, and paternal depression on cortisol intercept were qualified by the following significant interactions: 5-HTTLPR X chronic family, 5-HTTLPR X paternal depression, and child sex X poor parenting. These three interactions will be discussed in the following paragraphs.

First, an interaction between 5-HTTLPR and chronic family stress in association with cortisol intercept was probed (see Figure 10). In children homozygous for the l allele of 5-HTTLPR, higher chronic family stress was associated with a significantly higher cortisol intercept, *unstandardized intercept coefficient* = .005, *SE* = .001, $t(322) = 4.347$, $p < .001$; this effect was not significant for children with an s allele. At high levels of chronic family stress, carrying at least one s allele was associated with a significantly lower cortisol intercept, *unstandardized intercept coefficient* = -.014, *SE* = .004, $t(322) = -3.982$, $p < .001$; this effect was not significant at low levels of chronic family stress..

An interaction was also found between 5-HTTLPR genotype and paternal depression in predicting cortisol intercept (see Figure 11). Carrying at least one s allele was associated with a significantly lower cortisol intercept only in children with no history of paternal depression, *unstandardized intercept coefficient* = -.007, *SE* = .002, $t(322) = -3.090$, $p = .002$, this effect was not significant for children with a paternal depression history. Additionally, having a history of paternal depression was associated with a significantly lower cortisol intercept

Table 12

Paternal depression and other factors predicting children's cortisol intercept, slope, and curvature in multi-level modeling

Fixed Effect	Coefficient (SE)	t-value	Variance component (SD)	Chi- squared test of variance
Cortisol intercept				
Intercept	.027(.001)	30.554***	.000(.010)	405.587**
Primary Caregiver Age	-.000(.000)	-.009		
Paternal Anxiety	-.004(.003)	-1.431		
Child Sex	-.001(.001)	-.696		
BDNF val66met	-.000(.002)	-.089		
5-HTTLPR	-.007(.002)	-3.090**		
Chronic Family Stress	.005(.001)	4.347***		
Poor Parenting	-.003(.002)	-2.402*		
Paternal Depression	-.010(.005)	-2.145*		
5-HTTLPR X Chronic Family Stress	-.004(.001)	-3.584***		
5-HTTLPR X Paternal Depression	.013(.007)	2.003*		
Child Sex X Poor Parenting	.004(.002)	2.105*		
Cortisol slope				
Intercept	.008(.001)	7.814***	.000(.015)	627.224***
Primary Caregiver Age	-.000(.000)	-1.440		
Paternal Anxiety	.009(.004)	2.404*		
Child Sex	.003(.002)	1.364		
BDNF val66met	-.001(.002)	-.582		
5-HTTLPR	.001(.003)	.274		
Chronic Family Stress	-.001(.002)	-.753		
Poor Parenting	.002(.002)	1.118		
Paternal Depression	-.004(.005)	-.814		

(continued)

5-HTTLPR X Chronic Family Stress	.002(.002)	1.079		
5-HTTLPR X Paternal Depression	.004(.007)	.621		
Child Sex X Poor Parenting	-.002(.003)	-.809		
Cortisol curvature				
Intercept	-.001(.000)	-5.692***	.000(.004)	862.038***
Primary Caregiver Age	.000(.000)	1.064		
Paternal Anxiety	-.001(.001)	-2.142*		
Child Sex	-.001(.000)	-1.443		
BDNF val66met	.000(.001)	.782		
5-HTTLPR	-.000(.001)	-.560		
Chronic Family Stress	.000(.000)	.549		
Poor Parenting	-.000(.001)	-.809		
Paternal Depression	.000(.001)	.643		
5-HTTLPR X Chronic Family Stress	-.000(.000)	-.885		
5-HTTLPR X Paternal Depression	-.001(.001)	-.404		
Child Sex X Poor Parenting	.000(.001)	.761		

† $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$; child sex: males = 0 and females = 1;

5-HTTLPR: l/l = 0 and s/s or s/l = 1; BDNF val66met: val/val = 0 and val/met or met/met = 1; both depression and anxiety were coded as 0 = no lifetime history of disorder, 1 = lifetime history of disorder.

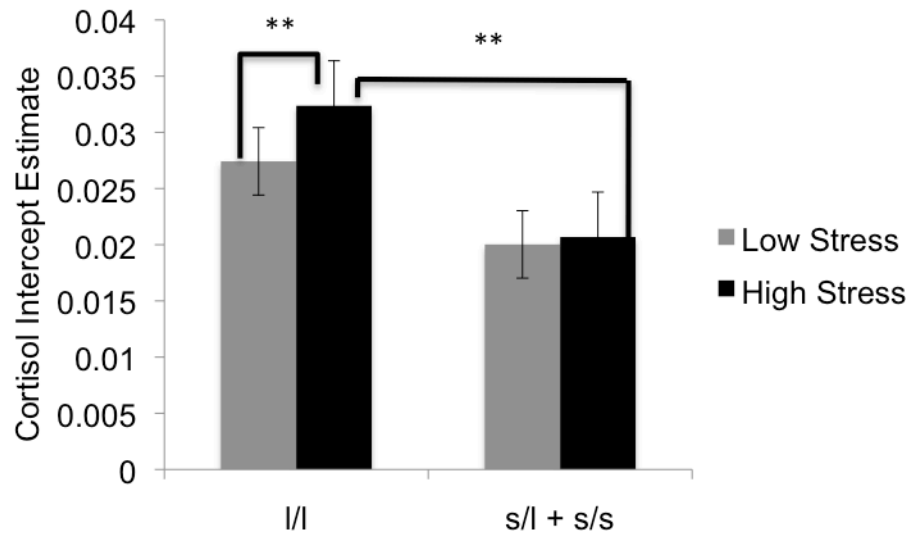


Figure 10. The association between 5-HTTLPR genotype and cortisol intercept as a function of chronic family stress. ** $p < .01$

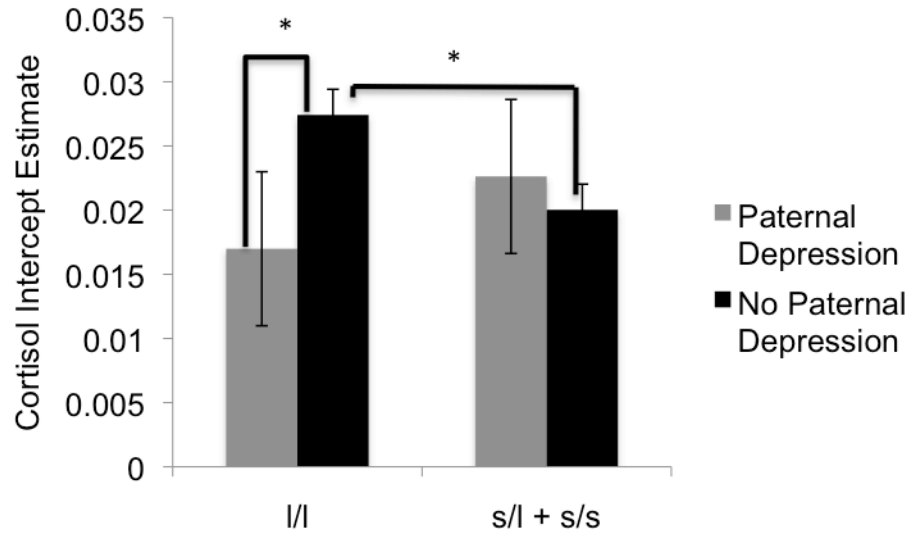


Figure 11. The association between 5-HTTLPR genotype and cortisol intercept as a function of paternal lifetime depression. * $p < .05$

only in children homozygous for the l allele of 5-HTTLPR, *unstandardized intercept coefficient* = -.010, *SE* = .005, $t(322) = -2.145$, $p = .033$, but was not associated with cortisol intercept in s carriers.

Finally, an interaction was found between child sex and poor parenting in predicting cortisol intercept (Figure 12). Poorer parenting was associated with a significantly lower cortisol intercept in boys only, *unstandardized intercept coefficient* = -.004, *SE* = .002, $t(322) = -2.402$, $p = .017$; this effect was not significant for girls. There was no significant effect of child sex at high or low levels of poor parenting.

Discussion

In the present study, I examined interactions between key biological and contextual markers of depression risk in association with cortisol reactivity to psychosocial stress in early childhood. To my knowledge, this study is the first to take a broad, multivariate approach to understanding correlates of early child cortisol reactivity to stress, examining multiple markers of biological and contextual risk together. I found evidence for interactions between several biological and contextual risk factors for depression in association with HPA axis functioning in this sample. Overall, my findings suggest that factors contributing to children's early HPA system functioning are complex, and that greater attention should be paid to how environmental stress is operationalized in diathesis-stress models of early cortisol function. Further, findings varied depending on how cortisol reactivity was indexed, suggesting that a greater understanding is needed regarding how different indices of cortisol function relate to vulnerability.

More specifically, with regard to how life stress is operationalized, I found that chronic stress and poor parenting, two salient forms of environmental stress for children this age (Lorant et al., 2003; Lupien, King, Meaney, & McEwen, 2000; Ormel, 2014; Smider et

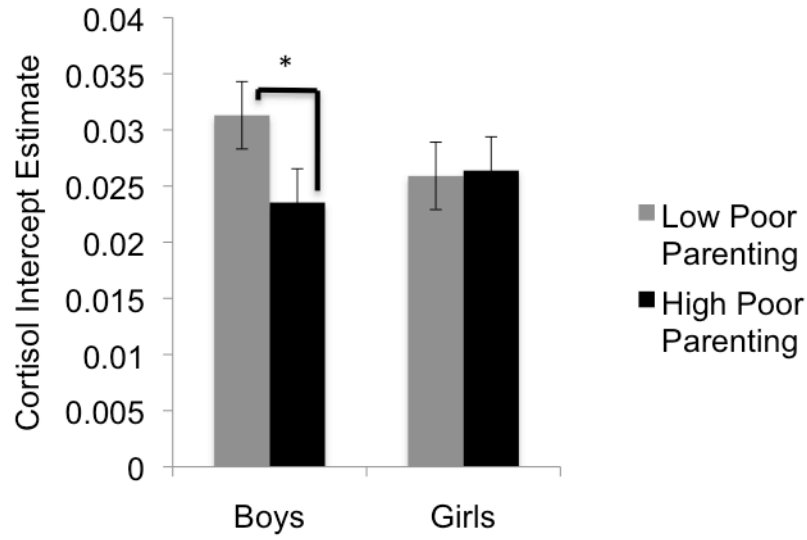


Figure 12. The association between child sex and cortisol intercept as a function of poor parenting. * $p < .05$

al., 2002), had very different associations with cortisol reactivity, particularly in the context of parent depression history. More specifically, marked cortisol reactivity indexed by AUCg was found in children of depressed caregivers exposed to high levels of chronic family stress, while attenuation of the cortisol response was found in these children when exposed to high levels of poor parenting. The latter finding is not inconsistent with previous literature finding decreased or “blunted” cortisol reactivity in individuals who experience early childhood maltreatment (e.g., Carpenter, Shattuck, Tyrka, Geraciotti, & Price 2011; MacMillan et al., 2009; Sumner, McLaughlin, Walsh, Sheridan, & Koenen, 2014), although the association between poor early care and cortisol was restricted to children with a depressed mother. Importantly, studies of the association between cortisol reactivity and more extremely negative aspects of early care (i.e., early maltreatment) generally do not take into account other risk factors, such as parent depression, which may be a crucial oversight if multifinality of the cortisol response is present based on such risks. In addition, it appears that the processes involved in cortisol reactivity in early childhood are somewhat different from the processes involved in baseline cortisol as it relates to HPA functioning, with paternal depression being more strongly associated with the latter.

Regarding how cortisol function is indexed, I found that the associations between poor parenting and child cortisol reactivity differed depending on the outcome, with MLM offering unique information that AUC cannot capture regarding both recovery and delayed reactivity. This suggests that studies examining cortisol reactivity as a risk marker may wish to use both indices (AUC and MLM), collect more than 5 samples post-stress, and include consideration of the potential limitations of the index chosen when interpreting results. In the sections that follow, I will review and discuss my findings in detail with attention to what component of HPA activity was being indexed in the model at hand.

Assessing Cortisol Reactivity to Psychosocial Stress

HPA reactivity to stress is an adaptive response, as it enables individuals to respond to potential threat (Selye, 1956). Dysregulation in this system, which can be expressed in terms of both hypo- and hyper-reactivity of the HPA response to psychosocial stress (Selye, 1974), represents a pathognomonic process that places individuals at risk for a variety of psychological and physiological problems (Jokinen & Nordstrom, 2009; Padgett & Glaser, 2003; Shea et al., 2005; Sapolsky, 2000; Sapolsky, Krey, & McEwen, 2002). This study used cortisol reactivity to psychosocial stress as an index of HPA function. Further, I used several different statistical procedures to model cortisol reactivity, procedures that are often used interchangeably in the literature. Importantly, findings were not always consistent across different indices of reactivity (AUC_i, AUC_g, and MLM), suggesting that the conclusions drawn from these various operationalizations of reactivity will differ, and must be considered in light of the different aspects of HPA axis function they purportedly tap. As consideration of how cortisol is operationalized will be pertinent to the interpretation of my findings, a brief review of the various cortisol indices is provided in the next section.

Cortisol indices and the HPA system. As the glucocorticoid end-product of the HPA system, cortisol exhibits diurnal fluctuation such that it is highest in the morning and declines throughout the day, reaching its lowest point a few hours after the onset of sleep (Selye, 1974). As cortisol levels are most stable during the afternoon (Schmidt-Reinwald et al., 1999), this is the optimal time during which to assess both baseline cortisol and reactivity, as values will be less influenced by diurnal rhythm. Baseline cortisol is often thought of as being a more trait-like and stable marker of HPA function, such that baseline cortisol is an index of the levels of cortisol that an individual is exposed to on a daily basis, across a long period of time, and independent of environmental conditions (Gunnar & Talge,

2008). In contrast, salivary cortisol values in response to stress are considered a state-like marker of HPA function and represent responsivity of the system to input from the immediate environment. Further, reactivity of the system includes both the initial cortisol increase post-stress and the system's recovery, or its ability to down-regulate to pre-stress levels following cessation of the stressor (Gunner & Talge, 2008). These different aspects of HPA system function are differentially emphasized depending on how cortisol reactivity is modelled. It can be argued that baseline cortisol, in a well-controlled study such as this one, can be indexed by examining cortisol intercepts via multi-level modelling techniques, although multiple data collection points are preferred when indexing basal or trait-life cortisol function (e.g., Dougherty et al., 2013). When cortisol is modelled at Level 1 in HLM, the intercept is a reflection of baseline cortisol within the sample, when time is grounded at the baseline making the cortisol intercept in MLM most akin to trait-like or basal HPA function.

However, other indices of cortisol also capture the influence of baseline cortisol. AUC_g is a measure of total cortisol across a sampling period and is in large part influenced by baseline cortisol values (Pruessner et al., 2003). In contrast, AUC_i indexes cortisol reactivity over and above baseline functioning and may be a better index of stress reactivity (Pruessner et al., 2003). We would therefore expect predictors of AUC_g to be more similar to those of cortisol intercept in MLM, and predictors of AUC_i to be most similar to those of cortisol slope (and curvature) in MLM, which was generally the case in the present study. This is further supported by the fact that AUC_i was positively correlated with all cortisol levels post-stress in this sample, but was not correlated with baseline cortisol. In contrast, AUC_g was positively correlated with baseline cortisol, suggesting that it is indeed partly reflective of trait-like cortisol function. Using both MLM and AUC indices allows stronger

inferences regarding which aspects of HPA function are influenced by these biological and contextual correlates.

Importantly, both AUC_g and AUC_i are incapable of capturing variation in the rate of HPA (cortisol) reactivity or recovery of the system over time. For example, an individual exhibiting a very slow and gradual increase in cortisol over a 50-minute sampling period may have AUC values that are quite low, despite the fact that this individual may have shown prolonged exposure to cortisol over time, if recovery was unusually slow and cortisol release extended far beyond the sampling period. This may have been true for children of depressed caregivers in our sample who were exposed to high levels of poor parenting; these children appeared to have a blunted response in AUC analyses as their AUC was significantly lower than children with a history of caregiver depression who were exposed to low levels of poor parenting. However, MLM revealed information that was not evident in models predicting AUC: namely, MLM analysis showed that, later in the sampling period, children with a maternal depression history who were exposed to high levels of poor parenting had a higher cortisol slope than children with a primary caregiver depression history who were exposed to low levels of poor parenting, consistent with the notion that the children with both risks exhibited a delayed recovery. Such a pattern of cortisol activity may indicate deficits in the capacity of the system to effectively downregulate, and can only be characterized with the use of multi-level modelling. It also suggests that especially long sampling periods post-stress may be required to fully understand the recovery process in children at such risk; even the fairly extensive sampling period used in the current study may not have been sufficiently long to fully capture this process.

In summary, interpretation of the effects of individual risk factors on HPA activity, indexed via salivary cortisol, should be informed by the specific statistical technique used to

index cortisol reactivity. Further, in cases in which downregulation of the cortisol response is thought to be relevant to the phenomenon of interest (e.g., depression vulnerability), MLM may be the methodology of choice, and extensive post-stress sampling may be warranted. Despite cortisol measures often being correlated, as they were in this sample, cortisol indices of HPA reactivity do not yield redundant results, despite largely being treated as interchangeable in the extant literature. As such, special attention will be paid to this issue when interpreting the results of this study.

Maternal depression models.

MLM analyses showed a moderated effect of maternal depression on both cortisol intercept and curvature, indicating that maternal depression may influence recovery of the HPA system, as well as basal functioning, in the context of poor parenting and chronic stress. No significant main effects or interactions were found in maternal depression models predicting AUC_i, suggesting that there may be a stronger association between maternal depression and baseline or trait-cortisol than reactivity; however, a significant effect was found on cortisol curvature in MLM, indicating that maternal depression is associated with post-stress recovery of the HPA axis. The impact of exposure to maternal depression during the child's lifetime on child cortisol was also moderated by poor parenting in association AUC_g, and with cortisol intercept and curvature in MLM. Indeed, whether children had experienced maternal depression exposure did not appear important for cortisol function when considering interactions between maternal depression and poor parenting, but it did in the context of chronic stress. Specifically, children's maternal depression exposure models showed similar results to those considering whether maternal depression history was present in models testing interactions with poor parenting; however, there was no interaction between children's maternal depression exposure and chronic stress in predicting AUC_g,

whereas there was for *lifetime* maternal depression. Children's maternal depression exposure interactions and their implications will be discussed in more detail later in the discussion.

A key finding among the interactions with maternal depression is the different pattern of effects of chronic family stress and poor parenting on child cortisol function. While high chronic family stress was associated with heightened reactivity in this group, poor parenting was associated with the opposite effect, such that children with a depressed mother had a distinctively low cortisol response in the context of high levels of poor parenting, as indexed by AUC_g and by a faster rate of curvature (i.e., a faster initial reduction in slope following the stressor) in MLM. Children with a maternal depression history were most reactive when exposed to low levels of poor parenting, by virtue of having a significantly higher AUC_g relative to children with a maternal depression history exposed to high levels of poor parenting, and children with no maternal depression exposed to low level of poor parenting. Interestingly, children with no history of maternal depression did not show associations between indices of cortisol reactivity and either chronic stress or poor parenting, displaying no significant change in cortisol at high or low levels of these environmental stress variables. This suggests that familial risk for depression transmitted via the mother may be associated with depression risk by virtue of its ability to sensitize offspring to different forms of early environmental stress. This study was not well-equipped to speak to the mechanisms by which such sensitization could occur; future studies may wish to examine whether maternal negative affect, negative cognition, or other processes play a role in mediating this effect. It is also likely that mothers' depression marks the presence of heritable factors that influence offspring stress reactivity; this idea will be discussed further in later sections.

Evolutionary theory posits that heightened reactivity during times of environmental stress is an adaptive response (Selye, 1956); in this light, the pattern of what could be

considered more normative cortisol reactivity displayed by children with a familial depression history in the context of chronic family stress could be considered adaptive, whereas the attenuated cortisol reactivity profile observed in children of depressed mothers with high poor parenting could be interpreted as maladaptive under their current environmental conditions. However, compared to children with no history of maternal depression, children with a maternal depression history exhibited an elevated total cortisol response when exposed to high level of chronic family stress, indicating that this response marks a pattern of cortisol dysregulation, albeit one distinct from the children of depressed mothers experiencing poor parenting. It is also important to note that children exposed to low levels of poor parenting who had a maternal depression history exhibited the highest levels of baseline cortisol, which may lead to prolonged exposure to cortisol over time and negative physical and psychological outcomes (de Felice et al., 2008; Gunnar & Talge, 2008; Pacak et al., 2002). While speculative, the exaggerated cortisol reactivity and high baseline cortisol in children with familial risk for depression at low levels of poor parenting suggests that children with maternal depression may be at risk for the development of a first episode of depression that is “reactive” in nature, or easily triggered by a major life event, by virtue of having especially heightened cortisol reactivity to stress that is readily triggered in response to environmental stimuli. Intriguingly, children without a maternal depression history who had high levels of poor parenting showed a similar pattern of exaggerated stress reactivity, as indexed by MLM models. This is consistent with notions of equifinality, in that there may be two distinct pathways to heightened cortisol stress reactivity, one related to familial depression vulnerability and another related to exposure to early adversity in the form of negative early care. Although the current study was not equipped to test such mechanisms,

the latter pathway is suggestive of underlying epigenetic programming of stress responses through variations in maternal care (Heim & Binder, 2012; Oberlander et al., 2008).

In contrast, children who experienced high poor parenting and had a history of maternal depression exhibited an attenuated cortisol response to a laboratory stressor, indexed via AUC_g and curvature in MLM. However, visual inspection of the cortisol estimates in MLM and analysis of recentered data suggest that these children exhibit a slow, steady increase in cortisol over the 50-minute sampling period. This information was not evident in analyses operationalizing cortisol reactivity using AUC. Had the sampling period extended further, it is possible that this group of children would have shown a return to baseline levels of cortisol later than other groups, and could suggest impairments in the capacity to downregulate the stress response system. While speculative, such impairments in downregulation could be related to biological differences in this group, such as other genetic influences not tested here (Sheikh, 2014). It is also possible that behavioural or cognitive processes occurring after cessation of the stress task contributed to this maladaptive pattern of reactivity. Indeed, children with a history of maternal depression who have experienced poor parenting may exhibit poor emotion regulation following the stressor, corresponding to literature showing such processes in children of depressed mothers and those exposed to poor parenting (e.g., Chang, Schwartz, Dodge, & McBride-Change, 2003; Feng et al., 2008); low regulatory traits have also been linked to depression vulnerability in middle childhood (Kotelnikova, Mackrell, Jordan, & Hayden, 2014). The children of depressed mothers exposed to poor parenting may have sustained negative affect following the stressor that they are ill-equipped to downregulate, resulting in a gradual increase in cortisol after the stressor has ceased. This finding complements work showing that post-stress rumination is linked to poor cortisol recovery post-stress in adolescence (Stewart et al., 2013). This notion could be

more directly tested in future work by extending the post-stress sampling period and coding child emotion and behavior during that time.

Additionally, future research may wish to examine neural correlates that characterize trait rumination in depressed individuals, such as heightened activation in brain systems including the default mode network (DMN) (Berman & Jonides, 2011; Thomason, Hamilton, & Gotlib, 2011). When the brain is not engaged in a specific attention-demanding or stimulus-dependent task, it switches gears into a default mode of stimulus-independent thought that is thought to be characterized by personal introspection, autobiographical memories, and thoughts of the future (Buckner, Andrews-Hanna, & Schacter, 2008). This DMN consists primarily of activation in the medial prefrontal cortex, posterior cingulate cortex, and the inferior temporal lobule, although other areas have been implicated (Whitfield-Gabrieli & Ford, 2012). Associations established between heightened DMN activity and poor cortisol recovery post-stress would lend support to the hypothesis that children with a history of maternal depression who are also exposed to poor parenting have difficulty disengaging emotionally from the stress task once it is over, thereby resulting in prolonged elevation in cortisol post stress. This would further improve our understanding of the neural substrates of HPA dysfunction in children at risk for depression. Importantly, research also shows that task engagement reduces DMN activity in depressed individuals such that they appear more like controls (Berman & Jonides, 2011), suggesting that this research could inform early preventative intervention in the form of the introduction of coping strategies (e.g., distraction) to children at risk for depression.

In discussing the interaction between maternal depression and poor parenting, the potential reciprocal influences that cognitive processes and HPA reactivity have on one another should also be considered (Schlosser, Wolf, & Wingenfeld, 2011). Given that

mothers with depression are more critical and hostile towards their children, engage in more coercive actions, and are more likely to negatively reinforce misbehaviour than control mothers (Cummings & Davies, 1994), it is possible that children of mothers with depression who also receive poor early care have acclimatized to psychosocial stress. Such habituation to psychosocial stress is potentially associated with reduced neural activity in emotion processing regions such as the amygdala or other regions of the frontal-limbic system during these situations (Hooley et al., 2005). Reduced activation in these areas could be followed by an attenuated HPA response, as these processes are “upstream” of the HPA axis, although reciprocal influences also exist (Joorman, Eugene, & Gotlib, 2009). Future research should examine both emotional and behavioural reactions to stress, in addition to functional neural responses in emotion-focused brain regions and structural changes in these regions (e.g., prefrontal cortex, amygdala, hippocampus, etc.) in children with and without exposure to maternal depression and critical parenting. In conjunction, research examining cortisol and neural responses to not only experimentally induced psychosocial stress, but also to maternal criticism, would be warranted. Previous research has reported failure to activate the dorsolateral prefrontal cortex in response to maternal criticism in individuals with a history of depression (Hooley et al., 2005). Given the high heritability of depression, it is possible that over-exposure to maternal criticism/poor parenting, related to maternal depression status, desensitized these individuals to stimuli of a similar nature in adulthood. Replicating this finding in children who are at familial risk for depression and including cortisol reactivity as another phenotypic risk marker would be a valuable extension of this work. To this author’s knowledge, no research has been done that would inform this theory, highlighting an important gap in the literature to date.

The interaction between maternal depression and poor parenting also indicates that future research should follow children over time to better understand how different early risks and patterns of HPA dysregulation relate to depression subtypes, given work linking cortisol reactivity to such subtypes in both children (e.g., Luby et al., 2003; Luby et al., 2004) and adults (e.g., Carroll et al., 1981; Gillespie & Nemeroff, 2005; Lamers et al., 2013). As mentioned previously, children with a history of maternal depression who experience low poor parenting, and children without a maternal depression history who experience high poor parenting, may be at greater risk for “reactive” forms of depression that occur after a significant life stressor. In contrast, children with a history of maternal depression who are exposed to high poor parenting may be at greater risk for melancholic depression, due to their attenuated reactivity profile which may leave them ill-equipped to cope with environmental stressors and results in a poorer prognosis. Consistent with this hypothesis, research suggests that melancholic depression may have greater genetic loading and tends to aggregate in families (Kendler et al., 1996) in addition to being more severe and resistant to pharmacological interventions (McGrath et al., 2008). This also corresponds with literature linking a blunted cortisol response post-stress to early adversity for individuals with more severe forms of depression (Harkness, Stewart, & Wynne-Edwards, 2011). Melancholic depression is distinguished from other forms of depression by the inclusion of anhedonia, or impaired reward function/lack of mood reactivity, as a key characteristic among other factors. Thus, attenuation in HPA activity may partially account for this reduced mood reactivity (or vice versa). Future research assessing the development of the HPA system and the reward salience network in conjunction, could inform how these two potential endophenotypes interact to produce different depression subtypes.

Given the cross-sectional nature of this study, it is not possible to determine how or when the attenuation of HPA reactivity occurs in children of depressed mothers who receive poor parenting, but the current findings speak to pathways that can be tested in future research. First, these findings suggest that prolonged exposure to heightened cortisol in children at familial risk for depression early in development due to negative parenting environment may have led to downregulation of the cortisol response to psychosocial stress. This theory is supported by previous literature showing that depressed youth often exhibit cortisol hyporeactivity to psychosocial stress after chronic mood dysregulation, chronic depression, or after a history of maltreatment, with this attenuated reactivity predicting greater depression severity (Ayer et al., 2013; Booij, Bouma, de Jonge, Ormel, & Oldehinkel, 2013; Burke et al., 2005; Harkness, Stewart, & Wynne-Edwards, 2011). The fact that children with a depressed mother who were exposed to chronic family stress, a more distal type of environmental stress in the life of a three-year old, exhibited heightened cortisol reactivity suggests that this hypothesis may have some merit. Indeed, chronic family stress may be a less potent environmental stressor for preschoolers, relative to the caregiving received. It is possible that children exposed to chronic family stress may also exhibit blunting of the cortisol response later in childhood as low SES, marital discord, and other chronic family stressors become more salient.

Children of depressed mothers, regardless of whether they had been exposed to maternal depression, exhibited significantly higher baseline cortisol and AUCg with *lower levels* of poor parenting as well as reduced curvature, indicating that, even in sensitive parenting contexts, these children are exposed to prolonged elevations in cortisol relative to children whose mothers were not depressed during their lifetime. This suggests the possibility that children at familial risk for depression have a genetic vulnerability to exhibit

downregulation of the cortisol system only *after* prolonged exposure to poor parenting and maternal depression, with these two stressors acting in conjunction to suppress the system.

Contrary to the lifetime maternal depression model, a significant interaction between maternal depression during the child's lifetime and chronic family stress in association with AUCg was not found. While also a function of the smaller sample of mothers available for this analysis, it also suggests that direct exposure to maternal depression does not contribute over and above the effect of lifetime maternal depression when considering the relationship between chronic life stress and AUCg. Perhaps the more important interaction found involving children's maternal depression exposure is that with child sex in predicting AUCi. This was the only effect present in children's maternal depression exposure models that was not present in *lifetime* maternal depression models. This effect existed despite no main effect of sex on any aspect of cortisol function being found in this sample. The absence of a sex difference in cortisol reactivity in our sample is consistent with the larger literature on salivary cortisol in childhood (Dettling et al., 1999; Lewis and Ramsay, 2002; for an exception, see Essex et al., 2002), as sex differences on this particular aspect of stress reactivity tend to emerge later in childhood and adolescence as children move through puberty (Stroud et al., 2011). Thus, it is possible that changes in other forms of risk that predominantly affect females and emerge later in life, such as biological changes, (e.g., hormonal) or increases in life stress, interact with cortisol reactivity to stress, leading to the emergence of sex differences in cortisol that are not evident earlier in development. My findings were consistent with this idea, as the sex by maternal depression interaction in this sample showed that girls exposed to maternal depression had significantly higher cortisol reactivity than boys who were similarly exposed. This is consistent with previous findings from this sample showing that females with higher levels of depressive symptoms had

greater cortisol reactivity in early childhood, whereas males did not (Kryski et al., 2013). As early emerging depressive symptoms and familial depression risk are both putative risk factors for the development of later disorder (Boland & Keller, 2009; Hammen, 2009), these findings complement each other, and provide further evidence for the existence of sex differences in risk that emerge earlier in life than perhaps previously thought. The current findings lend further support to the idea that heightened sensitivity to psychosocial stress may play a key role in explaining the preponderance of females who develop depression in early adolescence, a time when social evaluative pressures increase substantially (Compas, Orosan, & Grant, 1993).

Paternal depression models.

Although linkages between paternal anxiety and children's cortisol function were not the focus of the current research, an interesting finding was that paternal anxiety was significantly associated with children's cortisol slope and curvature such that children with a history of paternal anxiety had heightened reactivity to the stressor relative to children with no history of paternal anxiety. This could suggest that paternal anxiety has particularly strong biological associations with HPA function, and that children of anxious fathers have a biological predisposition to be more reactive to psychosocial stress. However, it could also be the case that fathers' anxiety is especially salient to even young children, and that early modeling or other environmental mediation of risk occurs, leading to heightened cortisol reactivity. While there is strong meta-analytic support suggesting that paternal depression is associated with greater child internalizing psychopathology (Kane & Garber, 2004), this study did not account comorbidity between paternal depression and other forms of psychopathology, such as anxiety. To this author's knowledge, this is the first study to examine the association between paternal anxiety and HPA reactivity, while taking into

account the effects of paternal depression, as well as other known biological and contextual risk factors. However, future research seeking to replicate this finding is warranted as the number of fathers in this study with anxiety was low.

In contrast to maternal depression models, where effects may have been most pronounced for girls, it appears that having a lifetime history of paternal depression may be particularly detrimental for boys. Specifically, an interaction was found between child sex and lifetime paternal depression in predicting AUC_i indicating that boys with a paternal depression history had significantly higher cortisol reactivity than both boys with no paternal depression history, and girls with a paternal depression history. These findings contradict previous literature demonstrating that adolescent girls were more impacted by paternal depression than boys (Reeb, Conger, & Wu, 2010), although Reeb and colleagues examined different indicators of functioning (not cortisol reactivity) in a very different age group. Regardless, to this author's knowledge, this is the first study to show that maternal and paternal depression differentially effect girls' and boys' psychophysiological depression risk. Possible reasons for these differing associations may be due to both genetic transmittance of paternal risk, or to the saliency of the mother-daughter and father-son relationship, making exposure to depression or correlates of depression (e.g., parenting, personality traits, etc.) in a same-sex parent particularly detrimental to development. This would be consistent with studies showing that closeness/cohesion and affective reactions of same sex parent-child dyads are stronger than opposite sex dyads (Russell & Saebel, 1997).

Child 5-HTTLPR genotype also interacted with paternal depression history to predict AUC_g and cortisol intercept, showing higher total cortisol in children homozygous for the *l* allele who had no history of paternal depression. This interaction, as well as the lack of a main effect of the 5-HTTLPR or interaction between 5-HTTLPR and life stress on cortisol

reactivity, is inconsistent with meta-analytic evidence linking the s allele of 5-HTTLPR to higher basal cortisol (Chen, Joorman, Hallmayer, & Gotlib, 2009; O'Hara et al., 2007; Wüst et al., 2009) and studies implicating the s allele in the context of gene-environment interaction (Armbruster et al., 2011). While it is possible that paternal depression history is an important moderator of the transmittance of 5-HTTLPR's effect on basal cortisol functioning, meta-analytic findings are generally considered more reliable than the findings produced by a single study, so it is possible that the interaction I found is a chance finding that will not replicate. Alternatively, it is possible that attempts to replicate this finding will reveal this effect to be robust, but only evident in young children, as the meta-analyses cited examined studies in older individuals. Additionally, is it possible that results are also dependent on how cortisol is operationalized. As previously stated, basal cortisol is typically measured across multiple days and was not indexed as such in this study.

Two interactions not involving parent depression were significant in paternal depression models, but not in maternal depression models; hence, these should be interpreted with caution given that they may not be robust effects. First, 5-HTTLPR interacted with chronic family stress and child sex interacted with poor parenting to predict cortisol intercept, or baseline cortisol, in the MLM model. Probing of the interaction between 5-HTTLPR and chronic family stress revealed that, surprisingly, the effect of life stress on baseline cortisol was only significant for l homozygotes, whereas children carrying an s allele demonstrate similar levels of baseline cortisol at high and low levels of chronic family stress. In addition, children with and without an s allele differed significantly in baseline cortisol only at high chronic family stress, with l homozygotes having significantly higher baseline cortisol. This was not what was expected, as previous literature has found heightened reactivity in s carriers versus l homozygotes in the context of high life stress (Mueller et al., 2011).

Nonetheless, these findings suggest that l homozygotes display the expected increase in HPA activity in the context of greater chronic family stress, whereas carriers of the s allele of 5-HTTLPR do not (Selye, 1974). The baseline cortisol of children carrying an s allele was not associated with chronic family stress, which may suggest that these children lack the appropriate psychophysiological coping mechanisms needed to cope with chronic stress, and may be a harbinger of poor coping later on in development (Joorman, Eugene, & Gotlib, 2009).

A second, unexpected interaction that was present only in paternal depression models showed that boys who received low levels of poor parenting had higher baseline cortisol relative to boys exposed to high levels of poor parenting. In short, exposure to poorer parenting was associated with a significant reduction in baseline cortisol for boys but not for girls. This could indicate that harsher parenting may lead to lower baseline cortisol and less internalizing disorder risk in boys, relative to sensitive caregiving. Interestingly, research has linked harsher parenting to greater externalizing problems in boys (Barnett & Scaramella, 2013), which has in turn been linked to cortisol hypoactivity (Fairchild et al., 2012), suggesting that low levels of poor parenting may also be driving boys' baseline cortisol down. Longitudinal research examining the effects of poor parenting on baseline cortisol over time and the subsequent consequences in terms of internalizing or externalizing sequelae is warranted, although I again note that this interaction, which was limited to models in which maternal depression was not included, must be interpreted with caution.

Other genetic findings. Contrary to previous research, I did not find any main effects of BDNF or 5-HTTLPR genotype on child cortisol (Chen, Joorman, Hallmayer, & Gotlib, 2009; Colzato et al., 2011). In addition, BDNF val66met genotype did not interact with life stress in any models to predict child cortisol (basal or reactivity), which would have been

consistent with previous work suggesting that BDNF val66met genotype moderates environmental influences on depression risk (Hayden et al., 2010). I also found no interaction between 5-HTTLPR genotype and life stress in association with cortisol reactivity (Mueller et al., 2011), although interactions were found relating to other aspects of cortisol function. The interaction I did find (i.e., the previously discussed interaction between 5-HTTLPR and chronic family stress predicting cortisol intercept in the context of paternal depression) was unexpected and contrasts with previous work on the 5-HTTLPR. The absence of previously reported effects in this sample was likely due to a wide variety of factors including sample size, how stress and cortisol were operationalized, and the age group being examined. In addition, as functioning in a system as complex as the HPA axis is due to a wide variety of genes working in concert in the cortisol signalling pathway, such as corticotropin-releasing hormone system polymorphisms (Sheikh, 2014; Sheikh, Kryski, Smith, Hayden, & Singh, 2013), it is possible that the genotypes selected for this study were not the most relevant to cortisol reactivity in early childhood.

Strengths, Limitations, and Future Research

Our study had a number of strengths, including a relatively large sample size, especially for a study comprised largely of observational, laboratory methods, and the use of a task that has been shown to elicit cortisol reactivity in young children (Kryski et al., 2011). We took steps to maximize the likelihood that we would obtain an accurate baseline measure of children's cortisol functioning, and obtained multiple cortisol samples post-stress. Another important strength includes the use of multi-method assessment of parenting, including the use of observational measures. Further, I examined multiple biological and contextual factors together in association with HPA reactivity, thus ensuring that any effects detected are present above and beyond shared variance with

other known risk factors. As the model fit statistics for AUC_i and AUC_g suggest, even the inclusion of many well-known risk markers accounts for only a small portion of the variance in cortisol reactivity. This further suggests that individual effects are likely to be small, and large samples such as this one may be needed in order to detect effects.

This study also indexed cortisol reactivity using both AUC and MLM, something that has not typically been done in this literature, although they index different aspects of the cortisol response. Inadequate sampling post-stress prevents many studies from examining cortisol curvature, as a minimum of four time points is required for a quadratic model (Singer & Willett, 2003); this was not a problem in the current research. Further, MLM provides additional information that AUC cannot, particularly when a quadratic model can be examined. For example, had MLM not been used in this study, we would not have seen evidence for a delay in HPA activation following stress in children of depressed mothers who were exposed to high levels of poor parenting, a finding which suggests that future research should sample cortisol at intervals beyond 50 minutes post-stress.

Despite the strengths of this study, several important limitations must also be noted. First, I ran multiple tests to examine the effect of biological and contextual risk factors on child cortisol as indexed via three different methods. While such an approach increases the likelihood of Type I error, I also did not want to overlook a potentially important, novel finding by applying overly stringent corrections to hypothesis-testing. Further, my analyses were designed to determine whether replication would be found across different cortisol indices, thus necessitating the use of multiple tests. Nevertheless, attempts at replicating these findings in future research are key.

Next, although I drew upon multiple waves of data collection, and although some

study factors clearly existed prior to child cortisol function (e.g., genetic factors), I conceptualized the study as essentially cross-sectional in nature; thus, the ability to speak to the processes through which the reported associations emerged is limited. Further, I cannot rule out the possibility that child cortisol function marks the presence of specific child behaviors that elicit poor parenting. Longitudinal data are needed to better understand the relationship between contextual risk factors and HPA axis activity across development; I consider this study an important initial step toward informing future theory-driven research aimed at better establishing causal links between early risk markers and HPA axis function. However, future research examining the mechanisms through which exposure to poor parenting and maternal depression contribute to children's cortisol reactivity is needed. In particular, exploration of neural (structure and function), emotional, and cognitive pathways to attenuated HPA reactivity in children with maternal depression and high poor parenting is needed (Alloy, Abramson, Smith, Gibb, & Neren, 2006; Taylor, Eisenberger, Saxbe, Lehman, & Lieberman, 2006). In addition, longitudinal examination of HPA axis changes across development combined with imaging techniques will help elucidate whether structural changes (e.g., reduced hippocampal volume) in individuals with depression precede changes in cortisol reactivity or are a result of chronic exposure to cortisol over time. Lastly, research examining whether children of depressed caregivers who display poor parenting are less emotionally reactive to parent criticism would address the question of whether these children have truly attenuated HPA systems or simply are less sensitive to psychosocial stress via chronic exposure to this type of threat. This research should be done in conjunction with examination of reactivity of emotion salience systems (e.g., amygdala activity) as biological changes in these systems related to chronic exposure to stress and

criticism could also be involved in attenuating the HPA response. A complement to this research would be exploration of how cognition and perception of criticism also play a role.

While attempts were made to examine differential effects of exposure to parent depression versus familial risk, this study was not well-equipped to address this problem. A larger sample would provide the power required for a more thorough examination of the effect of parent depression exposure on child cortisol functioning. Specifically, a larger sample would allow for fine-grained examination of the timing of depression exposure, which has been shown to be relevant in previous research (Dougherty et al., 2011). Future studies should also attempt to examine the effect of parent depression with a first onset during the child's lifetime to better disentangle parent depression chronicity from the specific effect of episodes occurring during the child's lifetime. Importantly, studies should account for potential gene-environment correlations and associated phenotypes (e.g., parent personality), which predate the onset of depression and may account for associations found between exposure to parent depression and child cortisol reactivity.

While this study sample was large for laboratory-based research, it is relatively small for a molecular genetics study; thus, replication of the findings involving 5-HTTLPR and BDNF val66met (or lack thereof) is of critical importance. As previously stated, exploration of other genotypes influencing HPA system function is also warranted. Future studies could also examine different indices of chronic family stress (i.e., marital discord, family income, and primary caregiver chronic stress) separately in association with cortisol, especially as children age, as specific types of life events and stressors (e.g., interpersonal) have been found to better predict first episode of depression (Monroe,

Rohde, Seeley, & Lewinsohn, 1999).

The findings of this study should not be generalized to children with clinical levels of depression, as research suggests that depression may have a scar effect on HPA axis activity. As such, findings of dysregulated HPA activity in clinical samples may reflect a consequence of depression rather than a biological vulnerability. Our sample reflects the demographics of the London community well. As such, the sample was primarily Caucasian and extreme levels of poor parenting and extremely high levels of chronic family stress were rare. Thus, our findings should not be generalized to diverse samples and future research should seek to include a wider range of poor parenting and chronic family stress.

Implications for Intervention

Although replication of these findings is needed, this study may have implications for the formulation of preventative interventions for children at high risk for depression via a history of maternal psychopathology. In particular, these findings suggest that parenting training for mothers with depression, in combination with stress-coping skills training for both mother and child, could be advantageous. This sort of targeted prevention program could improve outcomes for children of depressed mothers in two ways: First, parenting training could prevent attenuation of the cortisol response via the minimization of poor parenting exposure. Second, the provision of coping strategies to both mother and child would allow mothers to model more adaptive behavior for their children, and could also help children cope with future life stressors that could trigger a depressive episode. Family-based preventative interventions have been developed and shown to be useful for the offspring of depressed parents (Compas et al., 2011).

Lastly, this study found a main effect of chronic family stress and parent anxiety

on child HPA function, resulting in heightened baseline levels and reactivity respectively. This suggests that coping skills interventions may also be relevant for children at risk via a parent history of anxiety, or greater adversity exposure such as low SES, marital discord, or other chronic stressors. Targeted intervention for these children would most likely include behavioural strategies such as relaxation, which have been shown to be effective in young children (Courniere, 2004).

Conclusion

Our findings highlight the importance of considering how HPA reactivity is being indexed in future studies, with a recommendation that multiple ways of indexing reactivity be used whenever possible. This study found several unique associations between biological and contextual risk markers and HPA activity in early childhood. Importantly, some of these effects (e.g., those involving 5-HTTLPR) did not replicate in models in which primary caregiver or maternal psychopathology was controlled. The implications for future research are that shared variance between multiple risk factors should be accounted for when examining the effect of any one predictor, thus speaking more clearly to targeted intervention strategies.

This study revealed robust interactions between primary caregiver/maternal depression and poor parenting and chronic family stress in association with HPA reactivity in early childhood. This has important implications for future research as well potentially speaking to the development of targeted prevention programs for children at familial risk for depression. I found that children with a maternal depression history exhibited maladaptive, though distinct, stress responses in the context of high levels of chronic family stress or poor parenting. As such, targeted preventative interventions for children of depressed caregivers may be particularly advantageous. Future longitudinal

research is needed with attention to behavioural and neural mediators of the relationship between caregiver depression, poor parenting, chronic life stress, and HPA reactivity.

References

- Adam, E. K., Klimes-Dougan, B., & Gunnar, M. R. (2007). *Social regulation of the adrenocortical response to stress in infants, children, and adolescents: Implications for psychopathology and education*. New York: Guilford Press.
- Adrian, C., & Hammen, C. (1993). Stress exposure and stress generation in children of depressed mothers. *Journal of Consulting and Clinical Psychology, 61*, 354-359. doi:10.1037/0022-006X.61.2.354
- Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Thousand Oaks: Sage.
- Alexander, N., Kuepper, Y., Schmitz, A., Osinsky, R., Kozyra, E., & Hennig, J. (2009). Gene-environment interactions predict cortisol responses after acute stress: Implications for the etiology of depression. *Psychoneuroendocrinology, 34*, 1294-1303. doi:10.1016/j.psyneuen.2009.03.017
- Alexander, N., Osinsky, R., Schmitz, A., Mueller, E., Kuepper, Y., & Hennig, J. (2010). The BDNF Val66Met polymorphism affects HPA-axis reactivity to acute stress. *Psychoneuroendocrinology, 35*, 949-953. doi:10.1016/j.psyneuen.2009.12.008
- Alloy, L. B., Abramson, L. Y., Smith, J. M., Gibb, B. E., & Neeren, A. M. (2006). Role of parenting and maltreatment histories in unipolar and bipolar mood disorders: Mediation by cognitive vulnerability to depression. *Clinical Child and Family Psychology Review, 9*, 23-64. doi:10.1007/s10567-006-0002-4
- Andreasen, N. C., Endicott, J., Spitzer, R. L., & Winokur, G. (1977). The family history method using diagnostic criteria: Reliability and validity. *Archives of General Psychiatry, 34*, 1229-1235. doi:10.1001/archpsyc.1977.01770220111013
- Armbruster, D., Mueller, A., Strobel, A., Lesch, K., Brocke, B., & Kirschbaum, C. (2011).

- Predicting cortisol stress responses in older individuals: Influence of serotonin receptor 1A gene (HTR1A) and stressful life events. *Hormones and Behavior*, *60*, 105-111.
doi:10.1016/j.yhbeh.2011.03.010
- Ashman, S. B., Dawson, G., Panagiotides, H., Yamada, E., & Wilkinson, C. W. (2002). Stress hormone levels of children of depressed mothers. *Development and Psychopathology*, *14*, 333-349. doi:10.1017/S0954579402002080
- Ayer, L., Greaves-Lord, K., Althoff, R. R., Hudziak, J. J., Dieleman, G. C., Verhulst, F. C., & van der Ende, J. (2013). Blunted axis response to stress is related to a persistent dysregulation profile in youth. *Biological Psychology*, *93*, 343-351.
doi:10.1016/j.biopsycho.2013.04.002
- Azar, R., Paquette, D., Zoccolillo, M., Baltzer, F., & Tremblay, R. E. (2007). The association of major depression, conduct disorder, and maternal overcontrol with a failure to show a cortisol buffered response in 4-month-old infants of teenage mothers. *Biological Psychiatry*, *62*, 573-579. doi:10.1016/j.biopsych.2006.11.009
- Baillargeon, J., Dubois, G., & Marineau, R. (1986). Traduction française de l'échelle d'ajustement dyadique. *Canadian Journal of Behavioural Science/Revue Canadienne Des Sciences Du Comportement*, *18*, 25-34. doi:10.1037/h0079949
- Barden, N. (2004). Implication of the hypothalamic-pituitary-adrenal axis in the physiopathology of depression. *Journal of Psychiatry & Neuroscience*, *29*, 185-193.
- Barnett, M. A., & Scaramella, L. V. (2013). Mothers' parenting and child sex differences in behavior problems among African American preschoolers. *Journal of Family Psychology*, *27*, 773-783. doi:10.1037/a0033792
- Barr, C. S., Newman, T. K., Becker, M. L., Champoux, M., Lesch, K. P., Suomi, S. J., . . . Higley, J. D. (2003). Serotonin transporter gene variation is associated with alcohol

- sensitivity in rhesus macaques exposed to early-life stress. *Alcoholism: Clinical and Experimental Research*, 27, 812-817. doi:10.1097/01.ALC.0000067976.62827.ED
- Barr, C. S., Newman, T. K., Lindell, S., Shannon, C., Champoux, M., Lesch, K. P., Suomi, S. J., Goldman, D., & Higley, J. D. (2004). Interaction between serotonin transporter gene variation and rearing condition in alcohol preference and consumption in female primates. *Archives of General Psychiatry*, 61, 1146-1152.
- Bath, K. G., & Lee, F. S. (2006). Variant BDNF (Val66Met) impact on brain structure and function. *Cognitive, Affective & Behavioral Neuroscience*, 6, 79-85.
doi:10.3758/CABN.6.1.79
- Beck, A. T. (1967). *Depression*. New York: Harper and Row.
- Beevers, C. G., Rohde, P., Stice, E., & Nolen-Hoeksema, S. (2007). Recovery from major depressive disorder among female adolescents: A prospective test of the scar hypothesis. *Journal of Consulting and Clinical Psychology*, 75, 888-900.
doi:10.1037/0022-006X.75.6.888
- Bergström, A., Jayatissa, M. N., Mørk, A., & Wiborg, O. (2008). Stress sensitivity and resilience in the chronic mild stress rat model of depression; an in situ hybridization study. *Brain Research*, 1196, 41-52. doi:10.1016/j.brainres.2007.12.025
- Berman, M. G., & Jonides, J. (2011). Ruminating on rumination. *Biological Psychiatry*, 70, 310-311. doi:10.1016/j.biopsych.2011.06.003
- Blair, C., Granger, D. A., Kivlighan, K. T., Mills-Koonce, R., Willoughby, M., Greenberg, M. T., . . . Fortunato, C. K. (2008). Maternal and child contributions to cortisol response to emotional arousal in young children from low-income, rural communities. *Developmental Psychology*, 44, 1095-1109.
doi:10.1037/0012-1649.44.4.1095

- Boland, R. J., & Keller, M. B. (2009). Course and outcome of depression. In Gotlib, I. H., & Hammen, C. L. *Handbook of Depression* (2nd Ed) (pp. 23-43). New York: Guilford Press.
- Booij, S. H., Bouma, E. M. C., de Jonge, P., Ormel, J., & Oldehinkel, A. J. (2013). Chronicity of depressive problems and the cortisol response to psychosocial stress in adolescents: The TRAILS study. *Psychoneuroendocrinology*, *38*, 659-666.
doi:10.1016/j.psyneuen.2012.08.004
- Bouma, E., Riese, H., Nederhof, E., Ormel, J., & Oldehinkel, A. (2010). No replication of genotype effect of 5-HTTLPR on cortisol response to social stress in larger adolescent sample. *Biological Psychiatry*, *68*, 33-34. doi:10.1016/j.biopsych.2010.04.041
- Bradley, R. H., & Corwyn, R. F. (2002). Socioeconomic status and child development. *Annual Review of Psychology*, *53*, 371-399.
doi:10.1146/annurev.psych.53.100901.135233
- Brennan, P. A., Pargas, R., Walker, E. F., Green, P., Newport, D. J., & Stowe, Z. (2008). Maternal depression and infant cortisol: Influences of timing, comorbidity and treatment. *Journal of Child Psychology and Psychiatry*, *49*, 1099-1107.
doi:10.1111/j.1469-7610.2008.01914.x
- Buckner, R. L., Andrews-Hanna, J. R., & Schacter, D. L. (2008). The brain's default network: anatomy, function, and relevance to disease. *Annals of the New York Academy of Sciences*, *1124*, 1-38.
- Bugental, D. B., Martorell, G. A., & Barraza, V. (2003). The hormonal costs of subtle forms of infant maltreatment. *Hormones and Behavior*, *43*, 237-244.
doi:10.1016/S0018-506X(02)00008-9
- Burge, D., & Hammen, C. (1991). Maternal communication: Predictors of outcome at

- follow-up in a sample of children at high and low risk for depression. *Journal of Abnormal Psychology, 100*, 174-180. doi:10.1037/0021-843X.100.2.174
- Burke, H. M., Davis, S. C., Otte, C., & Mohr, D. C. (2005). Depression and psychological response to stress: A meta-analysis. *Psychoneuroendocrinology, 30*, 846-856. doi:10.1016/j.psyneuen.2010.07.006
- Burt, S. A., McGue, M., Krueger, R. F., & Iacono, W. G. (2005). Sources of covariation among the child-externalizing disorders: Informant effects and the shared environment. *Psychological Medicine, 35*, 1133-1144. doi:10.1017/S0033291705004770
- Carpenter, L. L., Shattuck, T. T., Tyrka, A. R., Geraciotti, T. D., & Price, L. H. (2011). Effect of childhood physical abuse on cortisol stress response. *Psychopharmacology, 214*, 367-375. doi:10.1007/s00213-010-2007-4
- Carroll, B. J., Feinberg, M., Greden, J. F., Tarika, J., Albala, A. A., Haskett, R. F., . . . Young, E. (1981). A specific laboratory test for the diagnosis of melancholia: Standardization, validation, and clinical utility. *Archives of General Psychiatry, 38*, 15-22.
- Caspi, A., Sugden, K., Moffitt, T. E., Taylor, A., Craig, I. W., Harrington, H., . . . Poulton, R. (2003). Influence of life stress on depression: Moderation by a polymorphism in the 5-HTT gene. *Science, 301*, 386-389. doi:10.1126/science.1083968
- Chang, L., Schwartz, D., Dodge, K. A., & McBride-Chang, C. (2003). Harsh parenting in relation to child emotion regulation and aggression. *Journal of Family Psychology, 17*, 598-606. doi:10.1037/0893-3200.17.4.598
- Chen, M. C., Joormann, J., Hallmayer, J., & Gotlib, I. H. (2009). Serotonin transporter polymorphism predicts waking cortisol in young girls. *Psychoneuroendocrinology, 34*,

681-686. doi:10.1016/j.psyneuen.2008.11.006

Chen, Z., Jing, D., Bath, K. G., Ieraci, A., Khan, T., Siao, C., . . . Lee, F. S. (2006). Genetic variant BDNF (Val66Met) polymorphism alters anxiety-related behavior. *Science*, *314*, 140-143. doi:10.1126/science.1129663

Chen, M. C., Joormann, J., Hallmayer, J., & Gotlib, I. H. (2009). Serotonin transporter polymorphism predicts waking cortisol in young girls. *Psychoneuroendocrinology*, *34*, 681-686. doi:10.1016/j.psyneuen.2008.11.006

Chen, Z. Y., Patel, P. D., Sant, G., Meng, C. X., Teng, K. K., Hempstead, B. L., & Lee, F. S. (2004). Variant brain-derived neurotrophic factor (BDNF) (Met66) alters the intracellular trafficking and activity-dependent secretion of wild-type BDNF in neurosecretory cells and cortical neurons. *The Journal of Neuroscience*, *24*, 4401-4411. doi:10.1523/JNEUROSCI.0348-04.2004

Chilcoat, H. D., & Breslau, N. (1997). Does psychiatric history bias mothers' reports? An application of a new analytic approach. *Journal of the American Academy of Child & Adolescent Psychiatry*, *36*, 971-979. doi:10.1097/00004583-199707000-00020

Cicchetti, D., & Rogosch, F. A. (2001). The impact of child maltreatment and psychopathology on neuroendocrine functioning. *Development and Psychopathology*, *13*, 783-804.

Colzato, L. S., Van der Does, A. J. W., Kouwenhoven, C., Elzinga, B. M., & Hommel, B. (2011). BDNF Val66Met polymorphism is associated with higher anticipatory cortisol stress response, anxiety, and alcohol consumption in healthy adults. *Psychoneuroendocrinology*, *36*, 1562-1569. doi:10.1016/j.psyneuen.2011.04.010

Compas, B. E., Champion, J. E., Forehand, R., Cole, D. A., Reeslund, K. L., Fear, J., . . .

- Roberts, L. (2010). Coping and parenting: Mediators of 12-month outcomes of a family group cognitive-behavioral preventive intervention with families of depressed parents. *Journal of Consulting and Clinical Psychology, 78*, 623-634. doi:10.1037/a0020459
- Compas, B. E., Orosan, P. G., & Grant, K. E. (1993). Adolescent stress and coping: Implications for psychopathology during adolescence. *Journal of Adolescence, 16*, 331-349. doi:10.1006/jado.1993.1028
- Conger, R. D., & Donnellan, M. B. (2007). An interactionist perspective on the socioeconomic context of human development. *Annual Review of Psychology, 58*, 175-199. doi:10.1146/annurev.psych.58.110405.085551
- Connolly, N. P., Eberhart, N. K., Hammen, C. L., & Brennan, P. A. (2010). Specificity of stress generation: A comparison of adolescents with depressive, anxiety, and comorbid diagnoses. *International Journal of Cognitive Therapy, 3*, 368-379. doi:10.1521/ijct.2010.3.4.368
- Coplan, J. D., Andrews, M. W., Rosenblum, L. A., Owens, M. J., Friedman, S., Gorman, J. M., & Nemeroff, C. B. (1996). Persistent elevations of cerebrospinal fluid concentrations of corticotrophin-releasing factor in adult nonhuman primates exposed to early-life stressors: Implications for the pathophysiology of mood and anxiety disorders. *Proceeding of the National Academy of Sciences of the United States of America, 93*, 1619-1623.
- Costello, E. J., Compton, S. N., Keeler, G., & Angold, A. (2003). Relationships between poverty and psychopathology: A natural experiment. *Journal of the American Medical Association, 290*, 2023-2029. doi:10.1001/jama.290.15.2023
- Courniere, L. C. (2004). *My Toes Feel Like Spaghetti: An Exploration of Relaxation Strategies for Preschool Children*. Unpublished masters thesis. Retrieved February

- 16th, 2010 from: <http://dtp.r.lib.athabasca.ca/files/caaproject/leonacorniereProject.pdf>.
- Cox, M., & Crnic, K. (2003). *Qualitative Ratings for Parent-Child Interaction at 3-15 months*. Unpublished coding manual. Center for Developmental Science, University of North Carolina at Chapel Hill.
- Cummings, E. M., & Davies, P. T. (1994). Maternal depression and child development. *Child Psychology & Psychiatry & Allied Disciplines*, 35, 73-112.
- Curran, P. J., Bauer, D. J., & Willoughby, M. T. (2006). Testing and probing interactions in hierarchical linear growth models. In Bergeman, C. S., & Boker, S. M. *Methodological issues in aging research* (Eds.) (pp. 99 -129). Mahwah: Lawrence Erlbaum Associates Publishers.
- Daniel, M., Moore, D. S., Decker, S., Belton, L., DeVellis, B., Doolen, A., & Campbell, M. K. (2006). Associations among education, cortisol rhythm, and BMI in blue-collar women. *Obesity*, 14, 327-335. doi:10.1038/oby.2006.42
- Dawson, G., Hessler, D., & Frey, K. (1994). Social influences of early developing biological and behavioral systems related to risk for affective disorder. *Development and Psychopathology. Special Issue: Neural Plasticity, Sensitive Periods, and Psychopathology*, 6, 759-779. doi:10.1017/S0954579400004776
- de Felice, C., Musaro, M., Peruzzi, L., Paffetti, P., Pasqui, L., Magaldi, R., . . . Latini, G. (2008). Early activation of the hypothalamic-pituitary-adrenal-axis in very-low-birth-weight infants with small thymus at birth. *The Journal of Maternal-Fetal & Neonatal Medicine*, 21, 251-254. doi:10.1080/14767050801927871
- De Los Reyes, A., & Kazdin, A. E. (2005). Informant discrepancies in the assessment of childhood psychopathology: A critical review, theoretical framework, and

recommendations for further study. *Psychological Bulletin*, *131*, 483-509.

doi:10.1037/0033-2909.131.4.483

Dettling, A. C., Gunnar, M. R., & Donzella, B. (1999). Cortisol levels of young children in full-day childcare centers: relations with age and temperament.

Psychoneuroendocrinology, *24*, 519-536. doi:10.1016/S0306-4530(99)00009-8

Dick, D. M. (2011). Gene-environment interaction in psychological traits and disorders.

Annual Review of Clinical Psychology, *7*, 383-409.

doi:10.1146/annurev-clinpsy-032210-104518

Dickerson, S. S., & Kemeny, M. E. (2004). Acute stressors and cortisol responses: A

theoretical integration and synthesis of laboratory research. *Psychological Bulletin*,

130, 355-391. doi:10.1037/0033-2909.130.3.355

Dorn, L. D., Kolko, D. J., Susman, E. J., Huang, B., Stein, H., Music, E., & Bukstein, O. G.

(2009). Salivary gonadal and adrenal hormone differences in boys and girls with and without disruptive behavior disorders: Contextual variants. *Biological Psychology*, *81*,

31-39. doi:10.1016/j.biopsycho.2009.01.004

Dougherty, L. R., Klein, D. N., Olino, T. M., Dyson, M., & Rose, S. (2009). Increased

waking salivary cortisol and depression risk in preschoolers: The role of maternal

history of melancholic depression and early child temperament. *Journal of Child*

Psychology and Psychiatry, *50*, 1495-1503. doi:10.1111/j.1469-7610.2009.02116.x

Dougherty, L. R., Klein, D. N., Rose, S., & Lupton, R. S. (2011).

Hypothalamic-pituitary-adrenal axis reactivity in the preschool-age offspring of

depressed parents: Moderation by early parenting. *Psychological Science*, *22*, 650-658.

doi:10.1177/0956797611404084

Dougherty, L. R., Smith, V. C., Olino, T. M., Dyson, M. W., Bufferd, S. J., Rose, S. A., &

- Klein, D. N. (2013). Maternal psychopathology and early child temperament predict young children's salivary cortisol 3 years later. *Journal of Abnormal Child Psychology*, *41*, 531-542. doi: 10.1007/s10802-012-9703-y
- D'Souza, U. M., & Craig, I. W. (2006). Functional polymorphisms in dopamine and serotonin pathway genes. *Human Mutation*, *27*, 1-13. doi:10.1002/humu.20278
- Duman, R. S., & Monteggia, L. M. (2006). A neurotrophic model for stress-related mood disorders. *Biological Psychiatry*, *59*, 1116-1127. doi:10.1016/j.biopsych.2006.02.013
- Dunn, L. M., & Dunn, L. M. (2007). *Peabody Picture Vocabulary Test (4th edition)*. Circle Pines: American Guidance Service.
- Durbin, C. E., Klein, D. N., Hayden, E. P., Buckley, M. E., & Moerk, K. C. (2005). Temperamental emotionality in preschoolers and parental mood disorders. *Journal of Abnormal Psychology*, *114*, 28-37. doi:10.1037/0021-843X.114.1.28
- Eames, S. F., Businelle, M. S., Suris, A., Walker, R., Rao, U., North, C. S., . . . Adinoff, B. (2014). Stress moderates the effect of childhood trauma and adversity on recent drinking in treatment-seeking alcohol-dependent men. *Journal of Consulting and Clinical Psychology*, *82*, 441-447. doi:10.1037/a0036291
- Eatough, E. M., Shirtcliff, E. A., Hanson, J. L., & Pollak, S. D. (2009). Hormonal reactivity to MRI scanning in adolescents. *Psychoneuroendocrinology*, *34*, 1242-1246. doi: 10.1016/j.psyneuen.2009.03.006
- Egeland, B., Weinfield, N., Hiester, M., Lawrence, C., Pierce, S., & Chippendale, K. (1995). *Teaching tasks administration and scoring manual*. University of Minnesota.
- Erel, O., & Burman, B. (1995). Interrelatedness of marital relations and parent-child relations: A meta-analytic review. *Psychological Bulletin*, *118*, 108-132. doi:10.1037/0033-2909.118.1.108

- Essex, M. J., Klein, M. H., Cho, E., & Kalin, N. H. (2002). Maternal stress beginning in infancy may sensitize children to later stress exposure: Effects on cortisol and behavior. *Biological Psychiatry*, *52*, 776-784. doi:10.1016/S0006-3223(02)01553-6
- Essex, M. J., Shirtcliff, E. A., Burk, L. R., Ruttle, P. L., Klein, M. H., Slattery, M. J., . . . Armstrong, J. M. (2011). Influence of early life stress on later hypothalamic-pituitary-adrenal axis functioning and its covariation with mental health symptoms: A study of the allostatic process from childhood into adolescence. *Development and Psychopathology*, *23*, 1039-1058. doi:10.1017/S0954579411000484
- Fairchild, G., van Goozen, Stephanie H. M., Stollery, S. J., Brown, J., Gardiner, J., Herbert, J., & Goodyer, I. M. (2008). Cortisol diurnal rhythm and stress reactivity in male adolescents with early-onset or adolescence-onset conduct disorder. *Biological Psychiatry*, *64*, 599-606. doi:10.1016/j.biopsych.2008.05.022
- Federenko, I. S., Schlotz, W., Kirschbaum, C., Bartels, M., Hellhammer, D. H., & Wüst, S. (2006). The heritability of perceived stress. *Psychological Medicine*, *36*, 375-385. doi:10.1017/S0033291705006616
- Feldman, R., Granat, A., Pariente, C., Kanety, H., Kuint, J., & Gilboa-Schechtman, E. (2009). Maternal depression and anxiety across the postpartum year and infant social engagement, fear regulation, and stress reactivity. *Journal of the American Academy of Child & Adolescent Psychiatry*, *48*, 919-927. doi:10.1097/CHI.0b013e3181b21651
- Feng, X., Shaw, D. S., Kovacs, M., Lane, T., O'Rourke, F. E., & Alarcon, J. H. (2008). Emotion regulation in preschoolers: The roles of behavioral inhibition, maternal affective behavior, and maternal depression. *Journal of Child Psychology and Psychiatry*, *49*, 132-141. doi:10.1111/j.1469-7610.2007.01828.x

- First, M. B., Gibbon, M., Spitzer, R. L., & Williams, J. B. W. (1996). *Structured clinical interview for DSM-IV Axis I disorders: Non-patient edition (SCID-I, Version 2.0)*. New York: Biometrics Research.
- Frigerio, A., Ceppi, E., Rusconi, M., Giorda, R., Raggi, M. E., & Fearon, P. (2009). The role played by the interaction between genetic factors and attachment in the stress response in infancy. *Journal of Child Psychology and Psychiatry*, *50*, 1513-1522. doi:10.1111/j.1469-7610.2009.02126.x
- Frodl, T., Schüle, C., Schmitt, G., Born, C., Baghai, T., Zill, P., . . . Meisenzahl, E. M. (2007). Association of the brain-derived neurotrophic factor Val66Met polymorphism with reduced hippocampal volumes in major depression. *Archives of General Psychiatry*, *64*, 410-416. doi:10.1001/archpsyc.64.4.410
- Gelernter, J., Kranzler, H., & Cubells, J. F. (1997). Serotonin transporter protein (SLC6A4) allele and haplotype frequencies and linkage disequilibria in African- and European-American and Japanese populations and in alcohol-dependent subjects. *Human Genetics*, *101*, 243-246. doi:10.1007/s004390050624
- Gibb, B. E., Benas, J. S., Grassia, M., & McGeary, J. (2009). Children's attentional biases and 5-HTTLPR genotype: Potential mechanisms linking mother and child depression. *Journal of Clinical Child and Adolescent Psychology*, *38*, 415-426. doi:10.1080/15374410902851705
- Gillespie, C. F., & Nemeroff, C. B. (2005). Hypercortisolemia and depression. *Psychosomatic Medicine*, *67*, S26-S28. doi:10.1097/01.psy.0000163456.22154.d2
- Givalois, L., Naert, G., Rage, F., Ixart, G., Arancibia, S., & Tapia-Arancibia, L. (2004). A single brain-derived neurotrophic factor injection modifies hypothalamic-pituitary-adrenocortical axis activity in male rats. *Molecular and*

Cellular Neuroscience, 27, 280-295. doi:10.1016/j.mcn.2004.07.002

Goodman, S. H. & Gotlib, I. H. (1999). *Children of parents with depression: Mechanisms of Risk and Implications for Treatment*. Needham Heights: Allyn & Bacon.

Goodyer, I. M., Croudace, T., Dudbridge, F., Ban, M., & Herbert, J. (2010). Polymorphisms in BDNF (Val66Met) and 5-HTTLPR, morning cortisol and subsequent depression in at-risk adolescents. *The British Journal of Psychiatry*, 197, 365-371.

doi:10.1192/bjp.bp.110.077750

Goodyer, I. M., Herbert, J., Tamplin, A., & Altham, P. M. E. (2000). First-episode major depression in adolescents: Affective, cognitive and endocrine characteristics of risk status and predictors of onset. *The British Journal of Psychiatry*, 176, 142-149.

doi:10.1192/bjp.176.2.142

Gotlib, I. H., Joormann, J., Minor, K. L., & Hallmayer, J. (2008). HPA axis reactivity: A mechanism underlying the associations among 5-HTTLPR, stress, and depression. *Biological Psychiatry*, 63, 847-851. doi:10.1016/j.biopsych.2007.10.008

Gottman, J. M., & Katz, L. F. (1989). The effect of marital discord on young children's peer interactions and health. *Developmental Psychology*, 25, 373-381.

doi:10.1037/0012-1649.25.3.373

Graham, J. W. (2009). Missing data analysis: Making it work in the real world. *Annual Review of Psychology*, 60, 549-576. doi:10.1146/annurev.psych.58.110405.085530

Granger, D. A., Serbin, L. A., Schwartzman, A., Lehoux, P., Cooperman, J., & Ikeda, S. (1998). Children's salivary cortisol, internalizing behavior problems, and family environment: Results from the Concordia longitudinal risk project. *International Journal of Behavioral Development*, 22, 707-728. doi:10.1080/016502598384135

Grant, K. E., Compas, B. E., Stuhlmacher, A. F., Thurm, A. E., McMahon, S. D., & Halpert,

- J. A. (2003). Stressors and child and adolescent psychopathology: Moving from markers to mechanisms of risk. *Psychological Bulletin*, *129*, 447-466.
doi:10.1037/0033-2909.129.3.447
- Groeneveld, M. G., Vermeer, H. J., van IJzendoorn, M. H., & Linting, M. (2012). Stress, cortisol and well-being of caregivers and children in home-based child care: A case for differential susceptibility. *Child: Care, Health and Development*, *38*, 251-260.
doi:10.1111/j.1365-2214.2010.01194.x
- Guerry, J. D. & Hastings, P. M. (2011). In search of HPA axis dysregulation in pediatric depression. *Clinical Child and Family Psychology Review*, *14*, 135-160. doi: 10.1007/s10567-011-0084-5
- Gunnar, M. R. (2000). Early adversity and the development of stress reactivity and regulation. In C. A. Nelson (Ed.), *The Minnesota symposia on child psychology, vol 31: The effects of early adversity on neurobehavioral development*. (pp. 163-200). Mahwah: Lawrence Erlbaum Associates Publishers.
- Gunnar, M. R., Brodersen, L., Nachmias, M., Buss, K., & Rigatuso, J. (1996). Stress reactivity and attachment security. *Developmental Psychobiology*, *29*, 191-204.
doi:10.1002/(SICI)1098-2302(199604)29:3<191::AID-DEV1>3.0.CO;2-M
- Gunnar, M. R., & Donzella, B. (2002). Social regulation of the cortisol levels in early human development. *Psychoneuroendocrinology. Special Issue: Stress and Drug Abuse*, *27*, 199-220. doi:10.1016/S0306-4530(01)00045-2
- Gunnar, M. R., Fisher, P. A., & The Early Experience, Stress, and Prevention Network. (2006). Bringing basic research on early experience and stress neurobiology to bear on preventative interventions for neglected and maltreated children. *Developmental and Psychopathology*, *18*, 651-677. doi:10.1017/S0954579406060330

- Gunnar, M. R., Morison, S. J., Chisholm, K., & Schuder, M. (2001). Salivary cortisol levels in children adopted from Romanian orphanages. *Development and Psychopathology. Special Issue: Stress and Development: Biological and Psychological Consequences*, *13*, 611-628. doi:10.1017/S095457940100311X
- Gunnar, M. R., & Talge, N. M. (2008). *Neuroendocrine measures in developmental research*. New York: Cambridge University Press.
- Gunnar, M. R., Talge, N. M., & Herrera, A. (2009). Stressor paradigms in developmental studies: What does and does not work to produce mean increases in salivary cortisol. *Psychoneuroendocrinology*, *34*, 953-967. doi:10.1016/j.psyneuen.2009.02.010
- Gunnar, M. R., & Vazquez, D. (2006). *Stress neurobiology and developmental psychopathology*. Hoboken: John Wiley & Sons Inc.
- Hagan, M. J., Roubinov, D. S., Gress-Smith, J., Luecken, L. J., Sandler, I. N., & Wolchik, S. (2011). Positive parenting during childhood moderates the impact of recent negative events on cortisol activity in parentally bereaved youth. *Psychopharmacology*, *214*, 231-238. doi:10.1007/s00213-010-1889-5
- Halligan, S. L., Herbert, J., Goodyer, I. M., & Murray, L. (2004). Exposure to postnatal depression predicts elevated cortisol in adolescent offspring. *Biological Psychiatry*, *55*, 376-381. doi:10.1016/j.biopsych.2003.09.013
- Hammen, C. (1991). Generation of stress in the course of unipolar depression. *Journal of Abnormal Psychology*, *100*, 555-561. doi:10.1037/0021-843X.100.4.555
- Hammen, C. (2005). Stress and depression. *Annual Review of Clinical Psychology*, *1*, 293-319. doi:10.1146/annurev.clinpsy.1.102803.143938
- Hammen, C. (2009). Children of depressed parents. In Gotlib, I. H., & Hammen, C. L. *Handbook of Depression* (2nd Ed) (pp. 275-297). New York: Guilford Press.

- Hammen, C., Brennan, P. A., & Shih, J. H. (2004). Family discord and stress predictors of depression and other disorders in adolescent children of depressed and nondepressed women. *Journal of the American Academy of Child & Adolescent Psychiatry, 43*, 994-1002. doi:10.1097/01.chi.0000127588.57468.f6
- Hammen, C. L., Gordon, D., Burge, D., Adrian, C., Jaenicke, C., & Hiroto, D. (1987). Maternal affective disorders, illness, and stress: Risk for children's psychopathology. *The American Journal of Psychiatry, 144*, 736-741.
- Hammen, C., Kim, E. Y., Eberhart, N. K., & Brennan, P. A. (2009). Chronic and acute stress and the prediction of major depression in women. *Depression and Anxiety, 26*, 718-723. doi:10.1002/da.20571
- Hankin, B. L., Badanes, L. S., Abela, J. R., & Watamura, S. E. (2010). Hypothalamic-pituitary-adrenal axis dysregulation in dysphoric children and adolescents: cortisol reactivity to psychosocial stress from preschool through middle adolescence. *Biological Psychiatry, 68*, 484-490. doi:10.1016/j.biopsych.2010.04.004
- Hariri, A. R., Goldberg, T. E., Mattay, V. S., Kolachana, B. S., Callicott, J. H., Egan, M. F., & Weinberger, D. R. (2003). Brain-derived neurotrophic factor val66 met polymorphism affects human memory-related hippocampal activity and predicts memory performance. *The Journal of Neuroscience, 23*, 6690-6694.
- Hariri, A. R., Mattay, V. S., Tessitore, A., Kolachana, B., Fera, F., Goldman, D., . . . Weinberger, D. R. (2002). Serotonin transporter genetic variation and the response of the human amygdala. *Science, 297*, 400-403.
- Harkness, K. L., Bruce, A. E., & Lumley, M. N. (2006). The role of childhood abuse and neglect in the sensitization to stressful life events in adolescent depression. *Journal of Abnormal Psychology, 115*, 730-741. doi: 10.1037/0021-843X.115.4.730

- Harkness, K. L., Stewart, J. G., & Wynne-Edwards, K. E. (2011). Cortisol reactivity to social stress in adolescents: Role of depression severity and child maltreatment. *Psychoneuroendocrinology*, *36*, 173-181.
doi:10.1016/j.psyneuen.2010.07.006
- Harris, T. O., Borsanyi, S., Messari, S., Stanford, K., Cleary, S. E., Shiers, H. M., . . . Herbert, J. (2000). Morning cortisol as a risk factor for subsequent major depressive disorder in adult women. *The British Journal of Psychiatry*, *177*, 505-510.
doi:10.1192/bjp.177.6.505
- Hayatbakhsh, R., Clavarino, A. M., Williams, G. M., Bor, W., O'Callaghan, M. J., & Najman, J. M. (2013). Family structure, marital discord and offspring's psychopathology in early adulthood: A prospective study. *European Child & Adolescent Psychiatry*, *22*, 693-700. doi:10.1007/s00787-013-0464-0
- Hayden, E. P., Dougherty, L. R., Maloney, B., Olino, T. M., Sheikh, H., Durbin, C. E., . . . Klein, D. N. (2008). Early-emerging cognitive vulnerability to depression and the serotonin transporter promoter region polymorphism. *Journal of Affective Disorders*, *107*, 227-230. doi:10.1016/j.jad.2007.07.028
- Hayden, E. P., Klein, D. N., Dougherty, L. R., Olino, T. M., Dyson, M. W., Durbin, C. E., . . . Singh, S. M. (2010). The role of brain-derived neurotrophic factor genotype, parental depression, and relationship discord in predicting early-emerging negative emotionality. *Psychological Science*, *21*, 1678-1685. doi:10.1177/0956797610385357
- Hayden, E. P., Olino, T. M., Bufferd, S. J., Miller, A., Dougherty, L. R., Sheikh, H. I., . . . Klein, D. N. (2013). The serotonin transporter linked polymorphic region and brain-derived neurotrophic factor valine to methionine at position 66 polymorphisms and maternal history of depression: Associations with cognitive vulnerability to

depression in childhood. *Development and Psychopathology*, 25, 587-598.

doi:10.1017/S0954579413000035

Hayes, A. F., & Matthes, J. (2009). Computational procedures for probing interactions in OLS and logistic regression: SPSS and SAS implementations. *Behavior Research Methods*, 41, 924-936. doi:10.3758/BRM.41.3.924

Health Canada. (2002). *A Report on Mental Illnesses in Canada*. Ottawa, Canada. Retrieved January 16th, 2014 from

<http://www.phac-aspc.gc.ca/publicat/miic-mmac/index-eng.php>

Heils, A., Teufel, A., Petri, S., Seemann, M., Bengel, D., Balling, U., Lesch, K. P. (1995). Functional promoter and polyadenylation site mapping of the human serotonin (5-HT) transporter gene. *Journal of Neural Transmission. General Section*, 102, 247-254. doi:10.1007/BF01281159

Heim, C., & Binder, E. B. (2012). Current research trends in early life stress and depression: review of human studies on sensitive periods, gene-environment interactions, and epigenetics. *Experimental Neurology*, 233, 102-11.

doi:10.1016/j.expneurol.2011.10.032

Heim, C., Newport, D. J., Bonsall, R., Miller, A. H., & Nemeroff, C. B. (2001). Altered pituitary-adrenal axis responses to provocative challenge tests in adult survivors of childhood abuse. *The American Journal of Psychiatry*, 158, 575-581.

doi:10.1176/appi.ajp.158.4.575

Hong, E. P., & Park, J. W. (2012). Sample size and statistical power calculation in genetic association studies. *Genomics & Informatics*, 10, 117-122.

doi:10.5808/GI.2012.10.2.117.

Hooley, J. M., Gruber, S. A., Scott, L. A., Hiller, J. B., & Yurgelun-Todd, D. A. (2005).

- Activation in dorsolateral prefrontal cortex in response to maternal criticism and praise in recovered depressed and healthy control participants. *Biological Psychiatry*, *57*, 809-812. doi:10.1016/j.biopsych.2005.01.012
- Hosang, G. M., Shiles, C., Tansey, K. E., McGuffin, P., & Uher, R. (2014). Interaction between stress and the BDNF Val66Met polymorphism in depression: a systematic review and meta-analysis. *BMC Medicine*, *12*, 1-11. doi:10.1186/1741-7015-12-7
- Huber, T. J., Issa, K., Schik, G. & Wolf, O. T. (2006). The cortisol awakening response is blunted in psychotherapy inpatients suffering from depression. *Psychoneuroendocrinology*, *31*, 900-904. doi:10.1016/j.psyneuen.2006.03.005
- Inder, W. J., Dimeski, G., & Russell, A. (2012). Measurement of salivary cortisol in 2012 - laboratory techniques and clinical indications. *Clinical Endocrinology*, *5*, 645-651. doi:10.1111/j.1365-2265.2012.04508.x.
- Ingram, R. E., & Luxton, D. D. (2005). Vulnerability-stress models. In Hankin, B. L., & Abela, J. R. Z. *Development of psychopathology: A vulnerability-stress perspective* (pp. 32-46). Thousand Oaks: Sage Publications.
- Ipsa, J. M., Fine, M. A., Halgunseth, L. C., Harper, S., Robinson, J., Boyce, L., Brooks-Gunn, J., & Brady-Smith, C. (2004). Maternal intrusiveness, maternal warmth, and mother-toddler relationship outcomes: variations across low income ethnic and acculturation groups. *Child Development*, *75*, 1613-1631. doi:10.1111/j.1467-8624.2004.00806.x
- Jabbi, M., Korf, J., Kema, I. P., Hartman, C., van der Pompe, G., Minderaa, R. B., . . . den Boer, J. A. (2007). Convergent genetic modulation of the endocrine stress response involves polymorphic variations of 5-HTT, COMT and MAOA. *Molecular Psychiatry*, *12*, 483-490. doi:10.1038/sj.mp.4001975

- Jiang, X., Wang, J., & Li, Q. (2009). Impaired hypothalamic-pituitary-adrenal axis and its feedback regulation in serotonin knockout mice. *Psychoneuroendocrinology*, *34*, 317-331. doi:10.1016/j.psyneuen.2008.09.011
- Johnson, J. G., Cohen, P., Dohrenwend, B. P., Link, B. G., & Brook, J. S. (1999). A longitudinal investigation of social causation and social selection processes involved in the association between socioeconomic status and psychiatric disorders. *Journal of Abnormal Psychology*, *108*, 490-499. doi:10.1037/0021-843X.108.3.490
- Johnson, P. O., & Neyman, J. (1936). Tests of certain linear hypotheses and their application to some educational problems. *Statistical Research Memoirs*, *1*, 57-93.
- Jokinen, J., & Nordstrom, P. (2009). HPA axis hyperactivity and cardiovascular mortality in mood disordered patients. *Journal of Affective Disorders*, *116*, 88-92. doi:10.1016/j.jad.2008.10.025
- Joormann, J. & Gotlib, I. H. (2009). Emotion Regulation and Stress Reactivity. In Rumsey J., & Ernst M. *Neuroimaging in Developmental Clinical Neuroscience* (pp. 38-52). New York: Cambridge University Press.
- Kane, P., & Garber, J. (2004). The relations among depression in fathers, children's psychopathology, and father-child conflict: A meta-analysis. *Clinical Psychology Review*, *24*, 339-360. doi:10.1016/j.cpr.2004.03.004
- Karg, K., Burmeister, M., Shedden, K., & Sen, S. (2011). The serotonin transporter promoter variant (5-HTTLPR), stress, and depression meta-analysis revisited: Evidence of genetic moderation. *Archives of General Psychiatry*, *68*, 444-454. doi:10.1001/archgenpsychiatry.2010.189
- Kaufman, J., Birmaher, B., Perel, J., Dahl, R. E., Moreci, P., Nelson, B., . . . Ryan, N. D. (1997). The corticotropin-releasing hormone challenge in depressed abused, depressed

nonabused, and normal control children. *Biological Psychiatry*, 42, 669-679.

doi:10.1016/S0006-3223(96)00470-2

Keller, P. S., Cummings, E. M., & Davies, P. T. (2005). The role of marital discord and parenting in relations between parental problem drinking and child adjustment. *Journal of Child Psychology and Psychiatry*, 46, 943-951.

doi:10.1111/j.1469-7610.2004.00399.x

Kendler, K. S., Eaves, L. J., Walters, E. E., Neale, M. C., Heath, A. C., & Kessler, R. C.

(1996). The identification and validation of distinct depressive syndromes in a population-based sample of female twins. *Archives of General Psychiatry*, 53, 391-399.

Kendler, K. S., Kuhn, J. W., Vittum, J., Prescott, C. A., & Riley, B. (2005). The interaction of stressful life events and a serotonin transporter polymorphism in the prediction of episodes of major depression. *Archives of General Psychiatry*, 62, 529-535.

doi:10.1001/archpsyc.62.5.529

Kim, J., Stewart, R., Kim, S., Yang, S., Shin, I., Kim, Y., & Yoon, J. (2007). Interactions between life stressors and susceptibility genes (5-HTTLPR and BDNF) on depression in Korean elders. *Biological Psychiatry*, 62, 423-428.

doi:10.1016/j.biopsych.2006.11.020

Klein, D. N., Lewinsohn, P., Rohde, P., Seeley, J., & Durbin, C. E. (2002). Clinical features of major depressive disorder in adolescents and their relatives: Impact on familial aggregation, implications for phenotype definition, and specificity of transmission.

Journal of Abnormal Psychology, 111, 98-106. doi:10.1037//0021-843X.111.1.98

Koch, F., Ludvigsson, J., & Sepa, A. (2010). Parents' psychological stress over time may affect children's cortisol at age 8. *Journal of Pediatric Psychology*, 35, 950-959.

doi:10.1093/jpepsy/jsp132

- Kotelnikova, Y., Mackrell, S. V. M., Jordan, P. J., & Hayden, E. P. (2014). Longitudinal Associations Between Reactive and Regulatory Temperament Traits and Depressive Symptoms in Middle Childhood. *Journal of Clinical Child and Adolescent Psychology*. Advance online publication. Retrieved May 20th, 2014 from <http://www.tandfonline.com/doi/full/10.1080/15374416.2014.893517#.U6YNq41dU78>
- Kryski, K. R., Dougherty, L. R., Dyson, M. W., Olino, T. M., Lupton, R. S., Hayden, E. P., & Klein, D. N. (2013b). Effortful Control and Parenting: Associations with HPA Axis Reactivity in Early Childhood. *Developmental Science*, *16*, 531-41. doi:10.1111/desc.12050
- Kryski, K. R., Smith, H. S., Sheikh, H. I., Singh, S. M., & Hayden, E. P. (2011). Assessing stress reactivity indexed via salivary cortisol in preschool-aged children. *Psychoneuroendocrinology*, *36*, 1127-1136. doi:10.1016/j.psyneuen.2011.02.003
- Kryski, K. R., Smith, H. J., Sheikh, H. I., Singh, S. M. & Hayden, E. P. (2013a). HPA Axis Reactivity to Stress in Early Childhood: Associations with Symptoms and Moderation by Sex. *Psychoneuroendocrinology*, *38*, 2327-36. doi: 10.1016/j.psyneuen.2013.05.002
- Kudielka, B. M. & Wüst, S. (2010). Human models in acute and chronic stress: assessing determinants of individuals' hypothalamus-pituitary-axis activity and reactivity. *Stress*, *13*, 1-14. doi:10.3109/10253890902874913
- Kuehner, C., Holzhauser, S., & Huffziger, S. (2007). Decreased cortisol response to awakening is associated with cognitive vulnerability to depression in a nonclinical sample of young adults. *Psychoneuroendocrinology*, *32*, 199-209. doi:10.1016/j.psyneuen.2006.12.007
- Lakey, B., & Edmundson, D. D. (1993). Role evaluations and stressful life events: Aggregate vs. domain-specific predictors. *Cognitive Therapy and Research*, *17*, 249-267.

- Lamers, F., van Oppen, P., Comijs, H. C., Smit, J. H., Spinhoven, P., van Balkom, Anton J. L. M., . . . Penninx, B. W. J. H. (2011). Comorbidity patterns of anxiety and depressive disorders in a large cohort study: The Netherlands study of depression and anxiety (NESDA). *Journal of Clinical Psychiatry, 72*, 341-348. doi:10.4088/JCP.10m06176blu
- Lamers, F., Vogelzangs, N., Merikangas, K. R., de Jonge, P., Beekman, A. T. F., & Penninx, B. W. J. H. (2013). Evidence for a differential role of HPA-axis function, inflammation and metabolic syndrome in melancholic versus atypical depression. *Molecular Psychiatry, 18*, 692-699. doi:10.1038/mp.2012.144
- Laurent, H. K., Leve, L. D., Neiderhiser, J. M., Natsuaki, M. N., Shaw, D. S., Harold, G. T., & Reiss, D. (2013). Effects of prenatal and postnatal parent depressive symptoms on adopted child HPA regulation: Independent and moderated influences. *Developmental Psychology, 49*, 876-886. doi:10.1037/a0028800
- Lesch, K. (2010). The role of serotonin transporter in modeling psychiatric disorders: Focus on depression, emotion regulation, and the social brain. In Kalueff, A. V., & LaPorte, J. L. *Experimental models in serotonin transporter research* (pp. 308-352). New York: Cambridge University Press.
- Lesch, K. P., Bengel, D., Heils, A., Sabol, S. Z., Greenberg, B. D., Petri, S., . . . Murphy, D. L. (1996). Association of anxiety-related traits with a polymorphism in the serotonin transporter gene regulatory region. *Science, 274*, 1527-31.
- Lesch, K. P., Gross, J., Franzek, E., & Wolozin, B. L. (1995). Primary structure of the serotonin transporter in unipolar depression and bipolar disorder. *Biological Psychiatry, 37*, 215-223. doi:10.1016/0006-3223(94)00147-U
- Lewis, M., & Ramsay, D. (2002). Cortisol response to embarrassment and shame. *Child Development, 73*, 1034-1045. doi:10.1111/1467-8624.00455

- Li, J. J., & Lee, S. S. (2014). Negative emotionality mediates the association of 5-HTTLPR genotype and depression in children with and without ADHD. *Psychiatry Research, 215*, 163-169. doi:10.1016/j.psychres.2013.10.026
- Linden, W., Earle, T. L., Gerin, W., & Christenfeld, N. (1997). Physiological stress and recovery: Conceptual siblings separated at birth? *Journal of Psychosomatic Research, 42*, 117-135. doi:10.1016/S0022-3999(96)00240-1
- Lopez-Duran, N. L., Hajal, N. J., Olson, S. L., Felt, B. T., & Vazquez, D. M. (2009). Individual differences in cortisol responses to fear and frustration during middle childhood. *Journal of Experimental Child Psychology, 103*, 285-295. doi:10.1016/j.jecp.2009.03.008
- Lopez-Duran, N. L., Kovacs, M., George, C. J. (2009). Hypothalamic–pituitary–adrenal axis dysregulation in depressed children and adolescents: A meta-analysis. *Psychoneuroendocrinology, 34*, 1272–1283. doi:10.1016/j.psyneuen.2009.03.016
- Lorant, V., Deliege, D., Eaton, W., Robert, A., Philippot, P., & Anseau, M. (2003). Socioeconomic inequalities in depression: a meta-analysis. *American Journal of Epidemiology, 157*, 98–112. doi:10.1093/aje/kwf182
- Lovejoy, M. C., Graczyk, P. A., O'Hare, E., & Neuman, G. (2000). Maternal depression and parenting behavior: A meta-analytic review. *Clinical Psychology Review, 20*, 561-592. doi:10.1016/S0272-7358(98)00100-7
- Luby, J. L., Heffelfinger, A. K., Mrakotsky, C., Brown, K. M., Hessler, M. J., Wallis, J. M., & Spitznagel, E. L. (2003). The clinical picture of depression in preschool children. *Journal of the American Academy of Child & Adolescent Psychiatry, 42*, 340-348. doi:10.1097/00004583-200303000-00015
- Luby, J. L., Mrakotsky, C., Heffelfinger, A., Brown, K., & Spitznagel, E. (2004).

- Characteristics of depressed preschoolers with and without anhedonia: Evidence for a melancholic depressive subtype in young children. *The American Journal of Psychiatry*, *161*, 1998-2004. doi:10.1176/appi.ajp.161.11.1998
- Lupien, S. J., King, S., Meaney, M. J., & McEwen, B. S. (2000). Child's stress hormone levels correlate with mother's socioeconomic status and depressive state. *Biological Psychiatry*, *48*, 976-980. doi:10.1016/S0006-3223(00)00965-3
- Luthar, S. S. (2006). Resilience in development: A synthesis of research across five decades. *Developmental psychopathology, vol 3: Risk, disorder, and adaptation* (2nd ed.) (pp. 739-795). Hoboken: John Wiley & Sons Inc.
- Mackrell, S. V. M., Sheikh, H. I., Kotelnikova, Y., Kryski, K. R., Jordan, P. L., Singh, S. M., & Hayden, E. P. (2014). Child temperament and parental depression predict cortisol reactivity to stress in middle childhood. *Journal of Abnormal Psychology*, *123*, 106-116. doi:10.1037/a0035612
- MacMillan, H. L., Georgiades, K., Duku, E. K., Shea, A., Steiner, M., Niec, A., . . . Schmidt, L. A. (2009). Cortisol response to stress in female youths exposed to childhood maltreatment: Results of the youth mood project. *Biological Psychiatry*, *66*, 62-68. doi:10.1016/j.biopsych.2008.12.014
- Magnano, C. L., Diamond, E. J., & Gardner, J. M. (1989). Use of salivary cortisol measurements in young children: A note of caution. *Child Development*, *60*, 1099-1101.
- Mannie, Z. N., Harmer, C. J., & Cowen, P. J. (2007). Increased waking salivary cortisol levels in young people at familial risk of depression. *The American Journal of Psychiatry*, *164*, 617-621. doi:10.1176/appi.ajp.164.4.617
- Masten, A. S. (2007). Resilience in developing systems: Progress and promise as the fourth

wave rises. *Development and Psychopathology*, *19*, 921-930.

doi:10.1017/S0954579407000442

Matsuo, K., Walss-Bass, C., Nery, F. G., Nicoletti, M. A., Hatch, J. P., Frey, B. N., . . .

Soares, J. C. (2009). Neuronal correlates of brain-derived neurotrophic factor

Val66Met polymorphism and morphometric abnormalities in bipolar

disorder. *Neuropsychopharmacology*, *34*, 1904-1913. doi:10.1038/npp.2009.23

McGrath, P. J., Khan, A. Y., Trivedi, M. H., Stewart, J. W., Morris, D. W., Wisniewski, S.

R., . . . Rush, A. J. (2008). Response to a selective serotonin reuptake inhibitor

(citalopram) in major depressive disorder with melancholic features: A STAR*D

report. *Journal of Clinical Psychiatry*, *69*, 1847-1855. doi:10.4088/JCP.v69n1201

McGuire, S. (2003). The heritability of parenting. *Parenting: Science and Practice*, *3*, 73-94.

doi:10.1207/S15327922PAR0301_04

Miller, G. E., Chen, E., & Zhou, E. S. (2007). If it goes up, must it come down? Chronic

stress and the hypothalamic-pituitary-adrenocortical axis in humans. *Psychological*

Bulletin, *133*, 25-45. doi:10.1037/0033-2909.133.1.25

Mills, R. S. L., Imm, G. P., Walling, B. R., & Weiler, H. A. (2008). Cortisol reactivity and

regulation associated with shame responding in early childhood. *Developmental*

Psychology, *44*, 1369-1380. doi:10.1037/a0013150

Moffitt, T. E., Caspi, A., & Rutter, M. (2005). Strategy for investigating interactions between

measured genes and measured environments. *Archives of General Psychiatry*, *62*,

473-481. doi:10.1001/archpsyc.62.5.473

Monroe, S. M., Rohde, P., Seeley, J. R., & Lewinsohn, P. M. (1999). Life events and

depression in adolescence: Relationship loss as a prospective risk factor for first onset

of major depressive disorder. *Journal of Abnormal Psychology*, *108*, 606-614.

doi:10.1037/0021-843X.108.4.606

- Monroe, S. M., & Simons, A. D. (1991). Diathesis–stress theories in the context of life stress research: Implications for the depressive disorders. *Psychological Bulletin*, *110*, 406–425. doi:10.1037//0033-2909.110.3.406
- Monroe, S. M., Slavich, G. M., & Georgiades, K. (2009). The social environment and life stress in depression. In Gotlib, I. H., & Hammen, C. L., *Handbook of depression* (2nd ed.), (pp. 340-360). New York: Guilford Press.
- Mörelus, E., Nelson, N., & Gustafsson, P. A. (2007). Salivary cortisol response in mother-infant dyads at high psychosocial risk. *Child: Care, Health and Development*, *33*, 128-136. doi:10.1111/j.1365-2214.2006.00637.x
- Mueller, A., Armbruster, D., Moser, D. A., Canli, T., Lesch, K., Brocke, B., & Kirschbaum, C. (2011). Interaction of serotonin transporter gene-linked polymorphic region and stressful life events predicts cortisol stress response. *Neuropsychopharmacology*, *36*, 1332-1339. doi:10.1038/npp.2011.11
- Mueller, A., Brocke, B., Fries, E., Lesch, K., & Kirschbaum, C. (2010). The role of the serotonin transporter polymorphism for the endocrine stress response in newborns. *Psychoneuroendocrinology*, *35*, 289-296. doi:10.1016/j.psyneuen.2009.07.002
- Murray, L., Halligan, S. L., Goodyer, I., & Herbert, J. (2010). Disturbances in early parenting of depressed mothers and cortisol secretion in offspring: A preliminary study. *Journal of Affective Disorders*, *122*, 218-223. doi:10.1016/j.jad.2009.06.034
- Naert, G., Ixart, G., Tapia-Arancibia, L., & Givalois, L. (2006). Continuous i.c.v. infusion of brain-derived neurotrophic factor modifies hypothalamic-pituitary-adrenal axis activity, locomotor activity and body temperature rhythms in adult male rats. *Neuroscience*, *139*, 779-789. doi:10.1016/j.neuroscience.2005.12.028

- Naicker, K., Wickham, M., & Colman, I. (2012). Timing of first exposure to maternal depression and adolescent emotional disorder in a national Canadian cohort. *PLoS ONE*, 7, Retrieved May 7th, 2014 from <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0033422>
- Najman, J. M., Williams, G. M., Nikles, J., Spence, S., Bor, W., O'Callaghan, M., . . . Shuttlewood, G. J. (2001). Bias influencing maternal reports of child behaviour and emotional state. *Social Psychiatry and Psychiatric Epidemiology*, 36, 186-194. doi:10.1007/s001270170062
- National Institute of Child Health and Human Development Early Child Care Research Network. (1997). The effects of infant child care on infant – mother attachment security: Results of the NICHD Study of Early Child Care. *Child Development*, 68, 860 – 879. doi:10.1111/j.1467-8624.1997.tb01967.x
- Natsuaki, M. N., Klimes-Dougan, B., Ge, X., Shirtcliff, E. A., Hastings, P. D., & Zahn-Waxler, C. (2009). Early pubertal maturation and internalizing problems in adolescence: sex differences in the role of cortisol reactivity to interpersonal stress. *Journal of Clinical Child and Adolescent Psychology*, 38, 513-524. doi:10.1080/15374410902976320
- Nederhof, E., Ormel, J., & Oldehinkel, A. J. (2014). Mismatch or cumulative stress: The pathway to depression is conditional on attention style. *Psychological Science*, 25, 684-692. doi:10.1177/0956797613513473
- Oberlander, T. F., Weinberg, J., Papsdorf, M., Grunau, R., Misri, S., & Devlin, A. M. (2008). Prenatal exposure to maternal depression, neonatal methylation of human glucocorticoid receptor gene (NR3C1) and infant cortisol stress responses. *Epigenetics*, 3, 97-106. doi:10.4161/epi.3.2.6034

- O'Connor, T. G., & Scott, S. B. C. (2006). Promoting children's adjustment: Parenting research from the perspective of risk and protection. In Garralda, M. E., & Flament, M., *Working with children and adolescents: An evidence-based approach to risk and resilience* (pp. 67-93). Lanham: Jason Aronson.
- Office of the Auditor General of Canada, 2001. 2001 December report of the auditor general of Canada: Exhibit 9.5 – The cost of depression. Retrieved July 30th, 2014 from http://www.oag-bvg.gc.ca/internet/English/att_0109xe05_e_11600.html.
- O'Hara, R., Schröder, C. M., Mahadevan, R., Schatzberg, A. F., Lindley, S., Fox, S., . . . Hallmayer, J. F. (2007). Serotonin transporter polymorphism, memory and hippocampal volume in the elderly: Association and interaction with cortisol. *Molecular Psychiatry*, *12*, 544-555. doi:10.1038/sj.mp.4001978
- Olino, T. M., Klein, D. N., Dyson, M. W., Rose, S. A., & Durbin, C. E., (2010). Temperamental emotionality in preschool-aged children and depressive disorders in parents: associations in a large community sample. *Journal of Abnormal Psychology*, *119*, 468-478. doi:10.1037/a0020112
- Ormel, J. (2014). *The Epidemiology of Mental Disorder in Adolescence: the Significance of Three Times Bad Luck*. Psychiatry grand rounds presentation conducted at Stony Brook University, Long Island, NY.
- Ouellet-Morin, I., Dionne, G., Pérusse, D., Lupien, S. J., Arseneault, L., Barr, R. G., . . . Boivin, M. (2009). Daytime cortisol secretion in 6-month-old twins: Genetic and environmental contributions as a function of early familial adversity. *Biological Psychiatry*, *65*, 409-416. doi:10.1016/j.biopsych.2008.10.003
- Pacak, K., Tjurmina, O., Palkovits, M., Goldstein, D. S., Koch, C. A., Hoff, T., & Chrousos, G. P. (2002). Chronic hypercortisolemia inhibits dopamine synthesis and turnover in

- the nucleus accumbens: An in vivo microdialysis study. *Neuroendocrinology*, *76*, 148-157. doi:10.1159/000064522
- Padgett, D. A., & Glaser, R. (2003). How stress influences the immune response. *Trends in Immunology*, *24*, 444-448. doi:10.1016/S1471-4906(03)00173-X
- Pedhazur, E. (1997). *Multiple regression in behavioral research: Explanation and prediction*. New York: Harcourt Brace.
- Pendry, P., & Adam, E. K. (2007). Associations between parents' marital functioning, maternal parenting quality, maternal emotion and child cortisol levels. *International Journal of Behavioral Development*, *31*, 218-231. doi:10.1177/0165025407074634
- Pinna, K. L. M. (2012). The cumulative effects of chronic and acute stress on HPA activity and depression in children who witness violence. *Dissertation Abstracts International: Section B: The Sciences and Engineering*, *7737*, Retrieved June 1st, 2014 from <http://search.proquest.com/docview/1036887190?accountid=15115>. (1036887190; 2012-99120-429).
- Pivac, N., Kim, B., Nedić, G., Joo, Y. H., Kozarić-Kovacić, D., Hong, J. P., & Muck-Seler, D. (2009). Ethnic differences in brain-derived neurotrophic factor Val66Met polymorphism in Croatian and Korean healthy participants. *Croatian Medical Journal*, *50*, 43-48. doi:10.3325/cmj.2009.50.43.
- Pluess, M., & Belsky, J. (2010). Differential susceptibility to parenting and quality child care. *Developmental Psychology*, *46*, 379-390. doi:10.1037/a0015203
- Pruessner, J. C., Kirschbaum, C., Meinlschmid, G., & Hellhammer, D. H. (2003). Two formulas for computation of the area under the curve represent measures of total hormone concentration versus time-dependent change. *Psychoneuroendocrinology*, *28*, 916-931. doi:10.1016/S0306-4530(02)00108-7

- Raposa, E. B., Hammen, C. L., Brennan, P. A., O'Callaghan, F., & Najman, J. M. (2014). Early adversity and health outcomes in young adulthood: The role of ongoing stress. *Health Psychology, 33*, 410-418. doi:10.1037/a0032752
- Reeb, B. T., Conger, K. J., & Wu, E. Y. (2010). Paternal depressive symptoms and adolescent functioning: The moderating effect of gender and father hostility. *Fathering, 8*, 131-142. doi:10.3149/fth.0801.131
- Rehm, L. P. (1977). A self-control model of depression. *Behavior Therapy, 8*, 787-804. doi:10.1016/S0005-7894(77)80150-0
- Repetti, R. L., Taylor, S. E., & Seeman, T. E. (2002). Risky families: Family social environments and the mental and physical health of offspring. *Psychological Bulletin, 128*, 330-366. doi:10.1037/0033-2909.128.2.330
- Richters, J. E. (1992). Depressed mothers as informants about their children: A critical review of the evidence for distortion. *Psychological Bulletin, 112*, 485-499. doi:10.1037/0033-2909.112.3.485
- Risbrough, V. B., & Stein, M. B. (2006). Role of corticotropin releasing factor in anxiety disorders: A translational research perspective. *Hormones and Behavior, 50*, 550-561. doi:10.1016/j.yhbeh.2006.06.019
- Robinson, C. C., Mandleco, B., Olsen, S. F., & Hart, C. H. (2001). The Parenting Styles and Dimensions Questionnaire (PSDQ). In Perimutter, B. F., Touliatos, J., & Holden, G. W., *Handbook of Family Measurement Techniques: Vol 3.* (pp. 319-321). Thousand Oaks: Sage.
- Rohde, P., Lewinsohn, P. M., & Seeley, J. R. (1997). Comparability of telephone and face-to-face interviews in assessing axis I and II disorders. *The American Journal of Psychiatry, 154*, 1593-1598.

- Ronsaville, D. S., Municchi, G., Laney, C., Cizza, G., Meyer, S. E., Haim, A., . . . Martinez, P. E. (2006). Maternal and environmental factors influence the hypothalamic-pituitary-adrenal axis response to corticotropin-releasing hormone infusion in offspring of mothers with or without mood disorders. *Development and Psychopathology, 18*, 173-194. doi:10.1017/S095457940606010X
- Russell, A., & Saebel, J. (1997). Mother-son, mother-daughter, father-son, and father-daughter: Are they distinct relationships? *Developmental Review, 17*, 111-147. doi:10.1006/drev.1997.0456
- Salimetrics (2008). *HS Cortisol Kit Information*. Unpublished Manuscript, State College, PA.
- Sapolsky, R. M. (2000). Glucocorticoids and hippocampal atrophy in neuropsychiatric disorders. *Archives of General Psychiatry, 57*, 925-935. doi:10.1001/archpsyc.57.10.925
- Sapolsky, R. M., Krey, L. C., & McEwen, B. S. (2002). The neuroendocrinology of stress and aging: The glucocorticoid cascade hypothesis. *Endocrine Reviews, 7*, 284-301. doi:10.1210/edrv-7-3-284
- Saridjan, N. S., Huizink, A. C., Koetsier, J. A., Jaddoe, V. W., Mackenbach, J. P., Hofman, A., . . . Tiemeier, H. (2010). Do social disadvantage and early family adversity affect the diurnal cortisol rhythm in infants? the generation R study. *Hormones and Behavior, 57*, 247-254. doi:10.1016/j.yhbeh.2009.12.001
- Schlosser, N., Wolf, O. T., & Wingenfeld, K. (2011). Cognitive correlates of HPA axis alterations and their relevance for therapeutic interventions in major depressive disorder. *Expert Review of Endocrinology and Metabolism, 6*, 109-126.
- Schmidt-Reinwald, A., Pruessner, J. C., Hellhammer, D. H., Federenko, I., Rohleder, N., Schürmeyer, T. H., & Kirschbaum, C. (1999). The cortisol response to awakening in

relation to different challenge tests and a 12-hour cortisol rhythm. *Life Sciences*, *64*, 1653-1660. doi:10.1016/S0024-3205(99)00103-4

Schüle, C., Zill, P., Baghai, T. C., Eser, D., Zwanzger, P., Wenig, N., . . . Bondy, B. (2006). Brain-derived neurotrophic factor Val66Met polymorphism and dexamethasone/CRH test results in depressed patients. *Psychoneuroendocrinology*, *31*, 1019-1025. doi:10.1016/j.psyneuen.2006.06.002

Selye, H. (1956). *The stress of life*. New York: McGraw-Hill.

Selye, H. (1975). Stress and distress. *Comprehensive Therapy*, *8*, 9 -13.

Shalev, I., Lerer, E., Israel, S., Uzefovsky, F., Gritsenko, I., Mankuta, D., . . . Kaitz, M. (2009). BDNF val66met polymorphism is associated with HPA axis reactivity to psychological stress characterized by genotype and gender interactions. *Psychoneuroendocrinology*, *34*, 382-388. doi:10.1016/j.psyneuen.2008.09.017

Shea, A., Walsh, C., MacMillan, H., & Steiner, M. (2005). Child maltreatment and HPA axis dysregulation: Relationship to major depressive disorder and post traumatic stress disorder in females. *Psychoneuroendocrinology*, *30*, 162-178. doi:10.1016/j.psyneuen.2004.07.001

Sheikh, H. I. (2014). *Association between hypothalamic-pituitary-adrenal axis system gene variants and cortisol reactivity in preschoolers: Main effects and gene-environment interactions*. Unpublished doctoral dissertation. University of Western Ontario, Department of Biology.

Sheikh, H. I., Hayden, E. P., Kryski, K. R., Smith, H. J., & Singh, S. M. (2010). Genotyping the BDNF rs6265 (val66met) polymorphism by one-step Amplified Refractory Mutation System PCR. *Psychiatric Genetics*, *20*, 109-112.

doi:10.1097/YPG.0b013e32833a2038

Sheikh H. I., Kryski, K. R., Smith, H. J., Hayden, E. P., & Singh, S. M. (2013).

Corticotropin-releasing hormone system polymorphisms are associated with children's cortisol reactivity. *Neuroscience*, *229*, 1-11. doi:10.1016/j.neuroscience.2012.10.056

Singer, J. D., & Willett, J. B. (2003). *Applied longitudinal data analysis: Modeling change and event occurrence*. New York: Oxford University Press.

Smider, N. A., Essex, M. J., Kalin, N. H., Buss, K. A., Klein, M. H., Davidson, R. J., &

Goldsmith, H. H. (2002). Salivary cortisol as a predictor of socioemotional adjustment during kindergarten: A prospective study. *Child Development*, *73*, 75-92.

doi:10.1111/1467-8624.00393

Spanier, G. (1976). Measuring dyadic adjustment: New scales for assessing the quality of marriage and similar dyads. *Journal of Marriage & the Family*, *38*, 15-28.

Sprague, J., Verona, E., Kalkhoff, W., & Kilmer, A. (2011). Moderators and mediators of the stress-aggression relationship: Executive function and state anger. *Emotion*, *11*, 61-73.

doi:10.1037/a0021788

Statistics Canada, (2006). *2006 Community Profiles – Census Metropolitan*

Area/Census Agglomeration: London Ontario. Retrieved November 2nd, 2010 from

<http://www12.statcan.ca/census-recensement/2006/dp-pd/prof/92-591/details/page.cfm>

?B1=All&Code1=555_&Code2=35&Custom=&Data=Count&Geo1=CMA&Geo2=PR

&Lang=E&SearchPR=01&SearchText=London&SearchType=Begins.

Statistics Canada. (2012). *Canadian Community Health Survey. Share File. Ontario*

MOHLTC. Retrieved November 2nd, 2010 from

[http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=3226&lang=e](http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=3226&lang=en&db=imdb&adm=8&dis=2#a5)

[n&db=imdb&adm=8&dis=2#a5](http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=3226&lang=en&db=imdb&adm=8&dis=2#a5)

- Steiger, H., Jooper, R., Gauvin, L., Bruce, K. R., Richardson, J., Israel, M., . . . Groleau, P. (2008). Serotonin-system polymorphisms (5-HTTLPR and -1438G/A) and responses of patients with bulimic syndromes to multimodal treatments. *Journal of Clinical Psychiatry, 69*, 1565-1571. doi:10.4088/JCP.v69n1006
- Steptoe, A., van Jaarsveld, C. H. M., Semmler, C., Plomin, R., & Wardle, J. (2009). Heritability of daytime cortisol levels and cortisol reactivity in children. *Psychoneuroendocrinology, 34*, 273-280. doi:10.1016/j.psyneuen.2008.09.006
- Stetler, C., & Miller, G. E. (2005). Blunted cortisol response to awakening in mild to moderate depression: Regulatory influences of sleep patterns and social contacts. *Journal of Abnormal Psychology, 114*, 697-705. doi:10.1037/0021-843X.114.4.697
- Stewart, J. G., Mazurka, R., Bond, L., Wynne-Edwards, K., & Harkness, K. L. (2013). Rumination and impaired cortisol recovery following a social stressor in adolescent depression. *Journal of Abnormal Child Psychology, 41*, 1015-1026. doi:10.1007/s10802-013-9740-1
- Stroud, L. R., Papandonatos, G. D., Williamson, D. E., & Dahl, R. E. (2011). Sex differences in cortisol response to corticotropin releasing hormone challenge over puberty: Pittsburgh pediatric neurobehavioral studies. *Psychoneuroendocrinology, 36*, 1226-1238. doi:10.1016/j.psyneuen.2011.02.017
- Suglia, S. F., Staudenmayer, J., Cohen, S., Enlow, M. B., Rich-Edwards, J., & Wright, R. J. (2010). Cumulative stress and cortisol disruption among black and hispanic pregnant women in an urban cohort. *Psychological Trauma: Theory, Research, Practice, and Policy, 2*, 326-334. doi:10.1037/a0018953
- Sullivan, P. F., Neale, M. C., & Kendler, K. S. (2000). Genetic epidemiology of major

- depression: Review and meta-analysis. *American Journal of Psychiatry*, *157*, 1552–1562. doi:10.1176/appi.ajp.157.10.1552
- Sumner, J. A., McLaughlin, K. A., Walsh, K., Sheridan, M. A., & Koenen, K. C. (2014). CRHR1 genotype and history of maltreatment predict cortisol reactivity to stress in adolescents. *Psychoneuroendocrinology*, *43*, 71-80. doi:10.1016/j.psyneuen.2014.02.002
- Talge, N. M., Donzella, B., Kryzer, E. M., Gierens, A., & Gunnar, M. R. (2005). It's not that bad: Error introduced by oral stimulants in salivary cortisol research. *Developmental Psychobiology*, *47*, 369-376. doi:10.1002/dev.20097
- Taylor, S. E., Eisenberger, N. I., Saxbe, D., Lehman, B. J., & Lieberman, M. D. (2006). Neural responses to emotional stimuli are associated with childhood family stress. *Biological Psychiatry*, *60*, 296-301. doi:10.1016/j.biopsych.2005.09.027
- Thomason, M. E., Hamilton, J. P., & Gotlib, I. H. (2011). Stress-induced activation of the HPA axis predicts connectivity between subgenual cingulate and salience network during rest in adolescents. *Journal of Child Psychology and Psychiatry*, *52*, 1026-1034. doi:10.1111/j.1469-7610.2011.02422.x
- Uher, R., & McGuffin, P. (2008). The moderation by the serotonin transporter gene of environmental adversity in the aetiology of mental illness: Review and methodological analysis. *Molecular Psychiatry*, *13*, 131-146. doi:10.1038/sj.mp.4002067
- Verschoor, E., & Markus, C. R. (2011). Effects of acute psychosocial stress exposure on endocrine and affective reactivity in college students differing in the 5-HTTLPR genotype and trait neuroticism. *Stress: The International Journal on the Biology of Stress*, *14*, 407-419. doi:10.3109/10253890.2010.548886
- Wankerl, M., Zyriax, B., Bondy, B., Hinkelmann, K., Windler, E., & Otte, C. (2010).

- Serotonin transporter gene-linked polymorphic region (5-HTTLPR) and diurnal cortisol: A sex by genotype interaction. *Biological Psychology*, *85*, 344-346.
doi:10.1016/j.biopsycho.2010.07.007
- Way, B. M., & Taylor, S. E. (2010). The serotonin transporter promoter polymorphism is associated with cortisol response to psychosocial stress. *Biological Psychiatry*, *67*, 487-492. doi:10.1016/j.biopsych.2009.10.021
- Weinfield, N. S., Egeland, B., & Ogawa, J. R. (1997). Promises to keep: Assessing affective and behavioral qualities of mother-child relationships in the new chance observational study. *Joint Center for Poverty Research Working Paper: Child Development*. Retrieved April 3rd, 2012 from <http://www.northwestern.edu/ipr/jcpr/workingpapers/childdev.html>
- Weissman, M. M., Wickramaratne, P., Nomura, Y., Warner, V., Pilowsky, D., & Verdeli, H. (2006). Offspring of depressed parents: 20 years later. *The American Journal of Psychiatry*, *163*, 1001-1008. doi:10.1176/appi.ajp.163.6.1001
- Wellhoener, P., Born, J., Fehm, H. L., & Dodt, C. (2004). Elevated resting and exercise-induced cortisol levels after mineralocorticoid receptor blockade with canrenoate in healthy humans. *The Journal of Clinical Endocrinology and Metabolism*, *89*, 5048-5052. doi:10.1210/jc.2004-0086
- Whitfield-Gabrieli, S., & Ford, J. M. (2012). Default mode network activity and connectivity in psychopathology. *Annual Review of Clinical Psychology*, *8*, 49-76.
- Wichers, M., Kenis, G., Jacobs, N., Myin-Germeys, I., Schruers, K., Mengelers, R., . . . van Os, J. (2008). The psychology of psychiatric genetics: Evidence that positive emotions in females moderate genetic sensitivity to social stress associated with the BDNF Val66Met polymorphism. *Journal of Abnormal Psychology*, *117*, 699-704.

doi:10.1037/a0012909

Wisco, B. E., & Nolen-Hoeksema, S. (2010a). Interpretation bias and depressive symptoms:

The role of self-relevance. *Behaviour Research and Therapy*, *48*, 1113-1122.

doi:10.1016/j.brat.2010.08.004

Wisco, B. E., & Nolen-Hoeksema, S. (2010b). Valence of autobiographical memories: The

role of mood, cognitive reappraisal, and suppression. *Behaviour Research and*

Therapy, *48*, 335-340. doi:10.1016/j.brat.2009.11.009

Wüst, S., Kumsta, R., Treutlein, J., Frank, J., Entringer, S., Schulze, T. G., & Rietschel, M.

(2009). Sex-specific association between the 5-HTT gene-linked polymorphic region and basal cortisol secretion. *Psychoneuroendocrinology*, *34*, 972-982.

doi:10.1016/j.psyneuen.2009.01.011

Young, E. A., Vazquez, D., Jiang, H., & Pfeffer, C. R. (2006). Saliva cortisol and response to

dexamethasone in children of depressed parents. *Biological Psychiatry*, *60*, 831-836.

doi:10.1016/j.biopsych.2006.03.077

Zalewski, M., Lengua, L. J., Kiff, C. J., & Fisher, P. A. (2012). Understanding the relation of

low income to HPA-axis functioning in preschool children: Cumulative family risk and parenting as pathways to disruptions in cortisol. *Child Psychiatry and Human*

Development, *43*, 924-942. doi:10.1007/s10578-012-0304-3

Zaslow, M. J., Weinfield, N. S., Gallagher, M., Hair, E. C., Ogawa, J. R., Egeland, B., . . . De

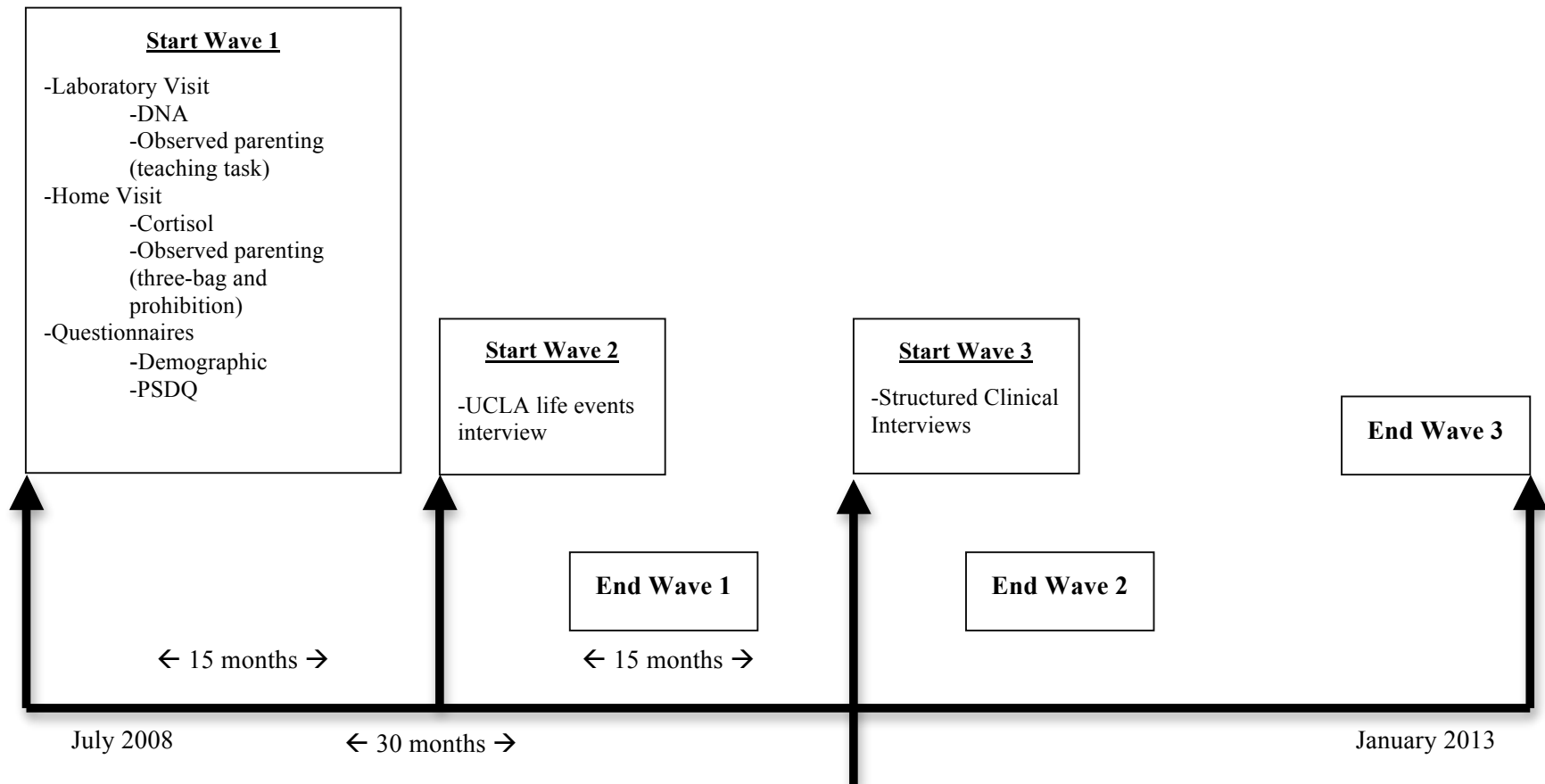
Temple, J. M. (2006). Longitudinal prediction of child outcomes from differing

measures of parenting in a low-income sample. *Developmental Psychology*, *42*, 27-37.

doi:10.1037/0012-1649.42.1.27

Appendix A

Figure 1A. Timeline showing study data collection



Appendix B: Parent-child interaction tasks coding manual & record form

Note: This coding system is derived from the Teaching Tasks coding manual and Qualitative Ratings for Parent-Child Interactions (Weinfield, Egeland, & Ogawa, 1998; Cox & Crnic, 2003).

CODING RATING SCALES

There are seven rating scales used for coding parent behaviour. The scales are:

Parent Sensitivity/Responsivity
 Parent Detachment
 Parent Supportive Presence
 Parent Intrusiveness
 Parent Hostility
 Parent Quality of Instruction
 Parent Confidence Parent Positive Affectivity
 Parent Negative Affectivity

Each scale is presented here, containing an initial description of the goals of the scale and a description of each rating point.

Parent Sensitivity/Responsivity: This scale focuses on how the parent observes and responds to their child's social gestures, expressions, and signals as well as how they respond to child negative affect. The key defining characteristic of a sensitive interaction is that it is child-centered. The sensitive parent is tuned to and manifests awareness of the child's needs, moods, interests, and capabilities, and allows this awareness to guide his/her interaction. A sensitive parent provides stimulation that is appropriate to the situation. He/she provides the child with contingent vocal stimulation and acknowledges the child's interest, efforts, affect, and accomplishments. A sensitive parent can spend time just watching the child but the difference between them and a detached parent is that the sensitive parent seems to be actively taking an interest in the child's activities, as evidenced by comments and embellishments when the child loses interest. A sensitive interaction is well timed and paced to the child's responses, a function of its child-centered nature. Such an interaction appears to be "in sync". The parent paces toys and games to keep the child interested and engaged, but also allows the child to disengage and independently explore the toys. Some markers of sensitivity include: (a) acknowledging the child's affect; (b) contingent vocalizations by the

parent; (c) appropriate attention focusing; (d) evidence of good timing paced to the child's interest and arousal level; (e) picking up on the child's interest in toys or games; (f) shared positive affect; (g) encouragement of child's efforts; (h) providing an appropriate level of stimulation when needed; and (i) sitting on floor or low seat, at child's level to interact.

No Sensitivity. There are almost no signs of parent sensitivity. Thus, the parent is either predominantly intrusive or detached. The parent rarely responds appropriately to the child's cues, and does not manifest awareness of the child's needs. Interactions are characteristically ill-timed or inappropriate. A parent who typically appears oblivious or punitive to the child's needs and affect would receive this score.

Very Low. This score would be given to parents who display weak or infrequent signs of sensitivity/responsiveness. While the parent is sometimes sensitive, the balance is clearly in the direction of insensitivity. The parent may give some delayed or perfunctory responses to cues from the child but the parent clearly appears more unresponsive than responsive.

Low. This rating should be given to parents who display some clear instances of sensitive responding. The parent can be characterized as sensitive to the child; however, the parent's behaviors may be mechanical in quality and ill-paced. The interaction can be characterized by a mixture of well-timed and faster paced episodes, or by a parent who is trying to be sensitive, but the interaction has signs of insensitivity. This rating may also be given to parents who are trying to interact appropriately with their child but he/she may appear not to know what to do. The parent is inconsistently sensitive and hard to categorize.

Moderate. This rating should be given to parents who are predominantly sensitive/responsive. The parent demonstrated sensitivity in most interactions but may neglect to give a fuller response or a well-timed, appropriate response. Some of the parent's responses are mixed, i.e. some are half-hearted or perfunctory, but the majority are full responses.

High. The rating should be given to parents who are exceptionally sensitive and responsive. Instances of sensitivity are rare and never striking. Interactions are characteristically well-timed and appropriate. Overall, most responses are prompt, appropriate, and effective.

Detachment/Disengagement: The detached parent appears emotionally uninvolved or

disengaged and unaware of the child's needs. This parent does not react contingently to the child's vocalizations or actions, and does not provide the "scaffolding" needed for the child to explore objects in novel ways. Detached parents either miss or ignore the child's cues for help with toys and games, and their timing is out of synchrony with the child's affect and responses (although not the overwhelming barrage of stimulation that intrusive parents present). Simply allowing the child to play by him/herself is not necessarily a sure sign of detachment; this can be appropriate at times, such as when the child is playing happily or contentedly and the parent checks in with the child visually. The detached parent will remain disengaged even when the child makes a bid for interaction with the parent. The detached parent is passive and lacks the emotional involvement and alertness that characterizes a sensitive parent. He/she appears uninterested in the child. There may be a "babysitter-like" quality to the interaction in that the parent appears to be somewhat attentive to the child, but behaves in an impersonal or perfunctory manner that fails to convey an emotional connection between the parent and the child. Other parents may demonstrate a performance-orientation in that the interaction is tailored towards performing for the camera rather than reacting to and facilitating child-centered behavior.

Not Detached. This rating should be given to parents who display almost no signs of detachment or under involvement. When interacting with the child, the parent is clearly emotionally involved. These parents can be sensitive or intrusive.

Minimal Detachment. This rating should be given to parents who display minimal signs of detachment. While they are clearly emotionally involved with the child during most of the interaction, there may be brief periods of detachment.

Somewhat Detached. This rating should be given to parents who remain involved and interested in the child while at the same time demonstrating the tendency to act in an uninterested, detached or perfunctory manner. Parents alternate between periods of engagement and disengagement. The periods of disengagement may be marked by unemotional or impersonal behavior. There may be a low-level of impersonal/unemotional behavior running throughout the interaction.

Moderately Detached. This rating should be given to parents who are predominantly detached. While there may be periods of engagement, the interaction is characterized chiefly by disengagement. The parent may be passive and fail to initiate interactions with the child. When interactions do occur, they may be marked by an impersonal, perfunctory style. Parent may show a lack of emotional engagement throughout the interaction.

Highly Detached. This rating should be given to parents who are extremely detached. The child plays without parent attention almost all of the time, even when the parent is within a suitable distance for interacting. In the minimal instances of involvement, the parent's behaviors are simple, mechanical, stereotyped, bland, repetitive, and perfunctory. The parent is clearly not emotionally involved with the child, and appears to be "just going through the motions".

Parent Supportive Presence: A parent scoring high on this scale expresses positive regard and emotional support to the child. This may occur by acknowledging the child's accomplishments on task the child is doing (e.g. building a house of blocks), encouraging the child with positive emotional regard (e.g. "You're really good at this"/"You got another one right") and various other ways of letting the child know that he/she has their support and confidence to do well in the setting (e.g. positive reassuring voice tone). If the child is having difficulty with a task, the parent is reassuring and calm, providing an affectively positive "secure base" for the child, perhaps leaning closer to the child to give a physical sense of support. A parent scoring low on this scale fails to provide supportive cues. They might be passive, uninvolved, aloof, or otherwise unavailable to the child. Such a parent also might give observers the impression that they are more concerned about their own adequacy in the setting than their child's emotional needs. A potential difficulty in scoring this scale is to discount messages by the parents that seemingly are supportive in verbal content but are contradicted by other aspects of the communication (e.g., the parent seems to be performing a supportive role for the camera and not really engaged in what the child is doing or feeling). Signs of such questionable support are improper timing of support, mismatch of verbal and bodily cues, and failure to have the child's attention in delivering the message. These types of supportive messages would not be weighted highly because such features suggest that supportive presence is not a well practiced aspect of their interaction outside the laboratory setting.

Parent completely fails to be supportive to the child, either being aloof and unavailable or being hostile toward the child when the child shows need of some support.

Parent provides very little emotional support to the child. Whatever supportive presence is displayed is minimal and not timed well, either being given when the child does not really need it, or only after the child has become upset.

Parent gives some support but it is sporadic and poorly timed to the child's needs. The consistency of this support is uneven so as to make the mother unreliable as a supportive presence.

Parent does a respectable job of being available when their child needs support. The parent may lean closer as the child shows small signs of frustration and praise the child's efforts to show that they are available and supportive, but inconsistency in this style makes support unreliable or unavailable at crucial times in the session.

Parent provides good support, reassurance and confidence in the child's ability, but falters in this at times when the child especially could use more support. Or, parent is universally supportive but gives no evidence of modulation to the child's needs.

Parent establishes him/herself as supportive and encouraging toward the child and continues to provide support when the child needs it. As the child experiences more difficulty, parent support increases in commensurate fashion. The parent has some lapses, however, in which the child's performance wavers for lack of support. Yet, they redouble support and attempt to return the child to a level of confidence that is more optimal.

Parent skillfully provides support throughout the session. Parent sets up the situation from the beginning as one in which they are confident of the child's efforts. Parent may reject inadequate solutions to problems in a way that does not reduce their support and confidence in the child's ability to get the correct solution. If the child is having difficulty, the parent finds ways to encourage whatever solution the child can make. Parent not only is emotionally supportive but continuously reinforces the child's success.

Parent Intrusiveness: A parent scoring high on this scale lacks respect for the child as an individual and fails to understand and recognize the child's effort to gain autonomy and self

awareness. This parent interferes with the child's needs, desires and interests or actual behaviors. The parent's behavior is guided more by their own agenda rather than the child's needs. Reasonable or appropriate limit setting or directing the child's behavior to the task may be intrusive, depending on the content of the parent's involvement. Setting limits is crucial to the socialization process at this age, and giving the child directives is part of many tasks. But behaviors are intrusive if they indicate a lack of respect for the child. Intrusiveness can occur in a harsh physical manner (parent grabbing the child's arms or hands and placing them somewhere else), or with affection (inappropriate contact which interferes with the child's efforts, such as kissing, hugging, etc.), or if the parent does not allow the child autonomy in problem-solving tasks (imposes directions and does not allow opportunities for self-directed efforts). It is important that intrusiveness be evaluated from the perspective of the child. Look at cues from the child preceding or after the parent's behavior to see how the child has perceived the parent's action; and what may seem as intrusive to the coders, may not be to the child (e.g., if fast-paced stimulation from the parent is enjoyed by the child, as shown by smiles or laughter, parental behavior that would otherwise be judged as intrusive will not be counted as such. However, because this judgment is highly subjective, this aspect should not carry a lot of weight when coding, but attention to context is important.)

No Intrusiveness: No sign of intrusiveness. The parent may be involved yet continues to respect the child's needs, or may alternatively be totally uninvolved with the child and appear withdrawn. In either case, the parent does not impose directives on the child unless it is clear that the child needs direction. If directives are given, it is in a manner showing respect for the child.

Very Low: Parent may show subtle signs of being intrusive, i.e. stepping in to help before the child demonstrates need, but the child does not perceive these as intrusive and is not upset by them.

Moderately Low: There is some indication of intrusiveness but it is not pervasive. These instances are of low intensity and again may not cause the child to become upset. For example, the parent may redirect the child to a new toy/task in a poorly timed fashion. Alternatively, low level intrusiveness may be "chronic"; however, the child has the opportunity to do some exploration.

Moderate: Clear signs of intrusiveness and/or a feeling of intrusiveness that is easily or clearly picked up by the coders, but parent still allows the child periods of exploration or autonomy. The instances of intrusiveness are generally of low intensity (i.e. the parent provides new instruction before the child has had a chance to complete the last task), yet there may be one high level act at an inappropriate time or there may be an episode of rough physical handling.

Moderately High: Clear signs that parent does not respect the child's needs and interests. There may be a couple high intensity, or several low level intrusive interactions. E.g., parent may often grab objects from the child, issue directives with no regard for child's response, or do much of the task for the child. However, parent may allow the child some periods of exploration or autonomy.

High: Clear incidents of intrusiveness throughout the session, and the parent's agenda clearly has precedence over the child's needs and interests. There may be either several high intensity intrusive interactions or persistent low level intrusive interactions. E.g., the parent may grab the child and physically direct behavior more than once, or the parent may be uninvolved for long periods, but whenever they do interact, these interactions are consistently intrusive. Parent also allows for less autonomy than exhibited in #5.

Very High: A highly intrusive parent's agenda clearly has precedence over the child's. Parent frequently intervenes inappropriately without cues from the child, and reacts to his/her own schedule rather than the child's needs. Frequent high level indicators (i.e. takes stimulus out of child's hands, no regard for what child wants to do, > #6) are pervasive throughout the session (i.e. parent appears to be doing task him/herself). Shows assertiveness to get the child to comply with their wishes which are not task related.

Parent Hostility: This scale reflects the parent's expression of anger, frustration, annoyance, discounting or rejecting of the child. A parent scoring high on this scale would clearly and openly reject the child, blame him or her for mistakes, and otherwise make explicit the message that they do not support the child emotionally. A parent scoring low on this scale may be either supportive or cold and show some expressions of anger, frustration, or annoyance, but they do not blame or reject the child. A rejecting parent may also show some Supportive Presence (and the inconsistency of their behavior would be revealed by these two

scores). Given the low frequency and the clinical relevance of rejecting one's child during a videotaped session, any events which are clearly hostile should be weighted strongly in this score.

1. Very low: Parent shows no signs of anger, annoyance, frustration, or rejection. They may or may not be supportive, but they do not try to put down the child or avoid the child in rejecting ways. Passive or emotionally uninvolved parents would be included here if the parent did not reject the child or communicate hostility toward the child.
2. Low: Parent did one or two things that seemed to communicate a little hostility (i.e. anger, frustration, annoyance) toward the child. These messages were not overt but rather muted expressions toward the child (e.g., pulling away something with a jerk, putting hand on their hip to show exasperation, giving a negative look at the child briefly, having an exasperated tone of voice, parroting or mimicking the child in a negative fashion).
3. Moderately low: Signs of hostility again are very fleeting, but they occurred on several occasions during the session, and at least one sign could be identified as clear and overt or an accumulating sense of unexpressed anger and avoidance toward the child was seen in the parent's behavior.
4. Moderate: Several instances of hostile or rejecting behaviors. Two or more of these events are reliably clear to observers, but expressions are brief and do not set the tone of parent's interactions immediately following the episodes.

Moderately high: Parent is overtly rejecting or hostile several times. Behaviors include overt and clearly communicated rejections of child and expressions of hostility or anger which appear intermittently through substantial periods of the session. This parent's behavior is more rejecting than not, either by the frequency of hostile behavior or by the potency by which rejection is communicated several times in the session.

High: Parent has frequent expressions of rejection and hostility directed toward the child. There is little or no effort to show warmth during substantial portions of the session, especially after parent becomes irritated with the child (i.e., parent may initially be warm and then rejects the child strongly). Parent is frankly and directly rejecting and hostile (e.g., telling child they will leave him/her behind if he/she does not do the task/play with the toy,

using negative performance feedback but little positive feedback, blaming the child for incompetence on the tasks, and overtly refusing to recognize the child's success, e.g., "You couldn't have done it without me showing you!"). Any warmth seems superficial relative to the parent's distancing from the child, and rejection is used as a control technique against the child.

7. Very high: Parent shows characteristics of the previous scale point, but expressions of anger toward the child also are accompanied by strong, barely controlled emotions, suggesting the possibility of physical abuse and neglect of the child in some situations.

Parent Quality of Instruction: The important features of this rating are how well the parent structures the situation so that the child knows what the task objectives are and receives hints or corrections while solving the problems that are: (a) timely to his/her current focus, (b) paced at a rate that allows comprehension and use of each hint, (c) graded in logical steps that the child can understand, and (d) stated clearly without unnecessary digressions to unrelated phenomena or aspects of the task that might only confuse the child. The parent's approach suggests that they have some sort of plan for how their instructions will help the child. Yet, the parent is also flexible in their approach and uses alternative strategies or rephrases suggestions when a particular cue is not working, and they coordinate their suggestions to the effort that the child is making to solve the task. See attached list for a more complete description of the components of quality instruction.

Parent's instructions are uniformly of poor quality. They either are totally uninvolved or fail to structure the tasks so that the child understands what is required, and the parent gives clues that are of no help to the child's problem-solving efforts and appear to embody no effective plan of teaching.

Parent occasionally gives effective instruction. Parent may be able to structure the tasks so that the child understands what to do and gives a few helpful hints to the child, but these are minimal compared to the ineffectiveness of most of their attempts or lack of attempts.

Parent effectively structures some portions of the tasks and provides good hints, but their assistance is inadequate for much of the session.

Parent provides adequate structure and instruction for the child to work on the tasks during

much of the session, but overall their instruction is lacking in major ways at several points during the session. Alternatively, the parent may approach tasks in a way that is very structured but requires the child to attend primarily to their directives and allows little opportunity for the child to engage the tasks directly (i.e., the parent therefore does not have to coordinate their teaching to the child's efforts); the result is that the child does not gain a sense of competence in performing the tasks.

Parent generally provides instruction that is sufficient and appropriate, but there are some periods in which it is inadequate in amount or quality. Alternatively, the parent may approach tasks in a way that is very structured but requires the child to attend primarily to their directives and allows little opportunity for the child to engage the task directly (i.e., the parent therefore does not have to coordinate their teaching to the child's efforts); yet, despite their directiveness, child still gains a sense of competence.

Parent's instruction demonstrates most of the desirable features for this rating and in general the parent appears to provide good help throughout the session.

Parent demonstrates almost all the characteristics of effective instruction consistently throughout the session. The tasks are sufficiently structured so that the child understands the objectives and can attempt to solve the problems directly. Parent's assistance coordinated to the child's activity and needs for assistance.

Components of Quality of Instruction (indicative of high quality instruction)

- obtains child's attention
- explains the goal of the task in a developmentally appropriate manner
- provides instructions which are contingent upon the child's previous action (e.g., child picks up a block; parent then tells child to find one that looks the same)
- structures the task into logical steps
- has a range of strategies which they can apply in response to the child's actions
- changes strategies when the current one is not working and does so in a timely manner
- provides appropriate feedback (e.g., okay, that's it, try again)
- uses developmentally appropriate language that their child can understand
- times their instructions based on child's actions; does not present instructions too quickly (while child is still working on previous step) or too slowly (long after the child first shows indications of needing help)
- persists despite difficulties; does not give up

Parent Confidence: Degree to which the parent seems to believe that they can work

successfully with the child in the situation and that the child will behave appropriately (whether this is more or less task oriented depends on parent's definition of the situation as a social or achievement oriented activity).

Mostly unconfident: Parent is uncertain in interactions with their child, being either unduly tentative, restricting, or appeasing (or a combination of these behaviors). Signs of a lack of confidence include doing the tasks for the child, appeasing the child by letting him do what he wants, overkill with strong reinforcement, showing clear signs of relief when the tasks go successfully, periodic checking with the experimenter to see if they are "doing it right", apologizing for behavior, and/or anxious laughter and giggling in response to their own or their child's efforts. There may be a sense that they are trying to deal with problem situations by using such tactics that distract from the issue rather than dealing with it directly.

Alternatively, a parent may not show tentativeness, but be overly power assertive/ intrusive /grabby in their attempts to control her child's behavior.

Somewhat unconfident: Parent seems fairly confident that they can interact with the child in ways that will be satisfactory; however they do show some evidence of hesitancy or appeasement or anxiety in making requests of the child. A few signs of a lack of confidence (as described above in 1) may be present but are not pervasive and do not persist throughout the session.

Mostly confident: Parent is quite confident that their interactions with the child will proceed in an acceptable manner and that they need not take special precautions to ensure this. Parent seems relaxed about interacting with their child and seems to believe that they could deal adequately with any problems that might arise. Parent trusts in their instincts and skills as a parent (whether or not we as coders believe that they should!).

Parent Positive Affectivity: This scale is a measure of the frequency and intensity of the parent's expression of positive affect (PA). Positive affect includes facial, vocal, and bodily components. A high score on this scale may be obtained even if the parent expresses negative affect in the session.

Low Parent PA: Parent shows very little or no positive affect throughout entire session.

Examples of low parent PA include lack of smiling, low energy, and subdued/ blunted/ flat affect.

Moderate Parent PA: Parent exhibits a few instances of positive affect (i.e. slight smiles). The majority of the PA displayed is of low intensity; however, there may be clear, but few, instances of moderate/high intensity PA (i.e. laughing, hugging the child). These elements are only minor elements of the session and are not expressed frequently or consistently.

High Parent PA: Parent clearly expresses PA at a level that is more intense and frequent than in #2. Parent appears energetic and engaged. Parent may display frequent low level instances of PA (i.e. contentment, smiling), but also displays several high level instances of PA.

Parent Negative Affectivity: This scale is a measure of the frequency and intensity of the parent's expression of negative affect (NA). Negative affect includes facial, vocal, and bodily components. A high score on this scale may be obtained even if the parent expresses positive affect in the session.

Low Parent NA: Parent shows very little or no negative affect throughout entire session. Examples of low parent NA include lack of irritability, frustration, or any other form of NA (i.e. anger, sadness, fear).

Moderate Parent NA: Parent exhibits a few instances of negative affect. The majority of the NA displayed is of low intensity (i.e. slightly negative tone of voice). These elements are only minor elements of the session and are not expressed frequently or consistently.

High Parent NA: Parent either expresses (1) consistent low levels of NA throughout the session, or (2) at least two clear instances of NA that are of greater intensity than in #2 (i.e. shouts at child, grabs child)

TASK NAME _____

SNUM _____

Scoring Sheet for Parent-Child Interaction Tasks Coding

Start time: _____ Stop time: _____

Coder Initials: _____ Date: _____

Behavior	Notes/Comments	Score
<i>Parent Sensitivity/Responsiveness</i>		
<i>Parent Detachment</i>		
<i>Parent Supportive Presence</i>		
<i>Parent Intrusiveness</i>		
<i>Parent Hostility</i>		
<i>Parent Quality of Instruction (code for puzzles with parent task only)</i>		
<i>Parent Confidence</i>		
<i>Parent Positive Affectivity</i>		
<i>Parent Negative Affectivity</i>		

KATIE ROSE KRYSKI, M.Sc., Ph.D. Candidate
Curriculum Vitae

EDUCATION

- In Progress **Doctor of Philosophy, Clinical Psychology**
University of Western Ontario, London, Ontario
Advisor: Elizabeth P. Hayden, Ph.D.
Dissertation: Biological and contextual predictors of HPA axis reactivity in early childhood
- 2010 **Master of Science, Clinical Psychology**
University of Western Ontario, London, Ontario
Advisor: Elizabeth P. Hayden, Ph.D.
Thesis: Development and validation of a developmentally-sensitive task for the induction of stress in preschool-aged children
- 2008 **Bachelor of Arts, Honours Psychology with Distinction**
University of Calgary, Calgary, Alberta
Advisor: Eric J. Mash, Ph.D., C. Psych.
Thesis: Maternal symptoms of Attention-Deficit/Hyperactivity Disorder and maternal language: Implications for infant language development

RESEARCH: PEER REVIEWED PUBLICATIONS

- Kryski, K. R.**, Smith, H.J., Sheikh, H.I., Singh, S.M., & Hayden, E.P. (2014). Evidence for evocative gene-environment correlation between child oxytocin receptor (OXTR) genotype and caregiver behavior. *Personality and Individual Differences*, *64*, 107-110. 10.1016/j.paid.2014.02.028
- Mackrell, S. V. M, Sheikh, H. I., Kotelnikova, Y., **Kryski, K. R.**, Jordan, P. L., Singh, S. M., Hayden, E. P. (2014). Child Temperament and Parental Depression Predict Cortisol Reactivity to Stress in Middle Childhood. *Journal of Abnormal Psychology*, *123*, 106-116. doi: 10.1037/a0035612.
- Kryski, K. R.**, Smith, H. J., Sheikh, H. I., Singh, S. M. & Hayden, E. P. (2013). HPA Axis Reactivity to Stress in Early Childhood: Associations with Symptoms and Moderation by Sex. *Psychoneuroendocrinology*, *38*, 2327-36. doi: 10.1016/j.psyneuen.2013.05.002
- Sheikh, H. I., **Kryski, K. R.**, Smith, H. J., Dougherty, L. R., Bufferd, S., Klein, D. N., Singh, S. M., & Hayden, E. P. (2013). Catechol-O-Methyltransferase gene *val158met* polymorphism and depressive symptoms during early childhood. *Neuropsychiatric Genetics*, *162*, 245-252. doi: 10.1002/ajmg.b.32141

Kryski, K. R., Dougherty, L. R., Dyson, M. W., Olino, T. M., Laptook, R. S., Hayden, E. P., & Klein, D. N. (2013). Effortful Control and Parenting: Associations with HPA Axis Reactivity in Early Childhood. *Developmental Science*, *16*, 531-41. doi: 10.1111/desc.12050

Smith, H. J., **Kryski, K. R.**, Sheikh, H. I., Singh, S. M., & Hayden, E. P. (2013). The role of positive parenting and dopamine D4 receptor gene polymorphisms in predicting children's inhibitory control. *Developmental Science*. *16*, 515-530. doi: 10.1111/desc.12046

Sheikh, H. I., Hayden, E. P., **Kryski, K. R.**, Smith, H. J., & Singh, S. M. (2013). Corticotropin-Releasing Hormone System Polymorphisms are Associated with Children's Cortisol Reactivity. *Neuroscience*, *229*, 1-11. doi: 10.1016/j.neuroscience.2012.10.056

Kryski, K. R., Smith, H. J., Sheikh, H. I., Singh, S. M., & Hayden, E. P. (2011). Assessing stress reactivity indexed via salivary cortisol in preschool-aged children. *Psychoneuroendocrinology*, *36*, 1127-1136. doi : 10.1016/j.psyneuen.2011.02.003

Kryski, K. R., Mash, E. J., Ninowski, J. E., & Semple, D. L. (2010). Maternal Symptoms of Attention-Deficit/Hyperactivity Disorder and Maternal Language: Implications for Infant Language Development. *Journal of Child and Family Studies*, *19*(3), 270-277. doi: 10.1007/s10826-009-9294-6

Sheikh, H. I., Hayden, E. P., **Kryski, K. R.**, Smith, H. J., & Singh, S. M. (2010). Genotyping the BDNF rs6265 (val66met) polymorphism by one-step Amplified Refractory Mutation System PCR. *Psychiatric Genetics*, *20*(3), 109-112. doi: 10.1097/YPG.0b013e32833a2038

Manuscripts Under Review:

Kotelnikova, Y., Olino, T. M., Klein, D. N., **Kryski, K. R.**, & Hayden, E. P. (under review). Higher- and Lower-Order Factor Analyses of the Children's Behavior Questionnaire in Early and Middle Childhood. *Psychological Assessment*.

Ouellette, S. J., Russell, E., **Kryski, K. R.**, Sheikh, H. I., Singh, S. M., Koren, G., & Hayden, E. P. (under review). Hair cortisol in high- and low-stress mother-daughter dyads: A pilot study of associations and moderators. *Developmental Psychobiology*.

Sheikh, H. I., Joannise, M. F., Mackrell, S. M., **Kryski, K. R.**, Smith, H. J., Singh, S. M., & Hayden, E. P. (under review). Associations between brain white matter microstructure and early age cortisol response to stress: Evidence for moderation by parenting. *Proceedings of the National Academy of Sciences of the United States of America*.

Manuscripts In Preparation:

Kryski, K. R., Olino, T. M., Klein, D. N., & Hayden, E. P. (in preparation). Temperamental Emotionality and Effortful Control in Preschool-Aged Children: Associations with Parental Psychopathology. University of Western Ontario and Stony Brook University.

Kryski, K. R., Dougherty, L. R., Sheikh, H. I., Singh, S. M., Klein, D. N., & Hayden, E. P. (in preparation). Maternal Depression and Cortisol Reactivity in Early Childhood: Longitudinal

Associations with Child Symptoms. *A Multi-Site Study*. University of Western Ontario and Stony Brook University.

RESEARCH: OTHER PUBLICATIONS

Evraire, L. & **Kryski, K. R.** (2013). Advocacy through Action: A Clinical Psychology Graduate Student Initiative. *Synopsis*, 35, 13.

Herzhoff, K., **Kryski, K.**, & Vanderlind, M. (2012). Article: June Gruber, Ph.D. Yale University. 2012 Early Career Award. Society for Research in Psychopathology, 2012 Student Driven Publication. Available at:
http://www.psychopathology.org/wp-content/uploads/2013/01/FINAL-SRPInterviews-ALL-2013_01_10.pdf

RESEARCH: PEER REVIEWED PRESENTATION (TALKS)

Sheikh, H.I., **Kryski, K.R.**, Smith, H.J., Hayden, E.P. & Singh, S.M. (May, 2013) Interactions between chronic early life stress and HPA axis reactivity moderates the link between GLP-1R gene polymorphism (Leu260Phe) and early-emerging internalizing symptoms. Invited presentation at the 68th Annual meeting of the Society of Biological Psychiatry, San Francisco, CA.

Sheikh, H. I., **Kryski, K. R.**, Smith, H. J., Hayden, E. P., & Singh, S. M. (2012). Genetic variants of the corticotropin-releasing hormone system related genes are associated with HPA axis reactivity in early-childhood. Society of Biological Psychiatry's 67th Annual Meeting, Philadelphia, PA.

Sheikh, H.I., **Kryski, K.R.**, Smith, H.J., Hayden, E.P. & Singh, S.M. Interaction Between Gene Polymorphisms of the Hypothalamic-Pituitary-Adrenal Axis and Early Parenting Predicts Cortisol Reactivity in Preschoolers. Invited presentation, University of Pittsburg, August 7th, 2012.

Kryski, K. R., Dougherty, L. R., Sheikh, H. I., Dyson, M. W., Olino, T. M., Laptook, R. S., Hayden, E. P., Singh, S. M., & Klein, D. N. (2011). DRD4 genotype, child effortful control, and parenting style: Associations with HPA axis reactivity in early childhood. In E. Fox (Chair), Attention control and anxiety: Integrating electrophysiological, cognitive and genetic approaches. Symposium conducted at the annual meeting of the Society for Psychophysiological Research, Boston, MA.

Kryski, K. R., Smith, H., Sheikh, H., Singh, S., & Hayden, E. "HPA Axis Reactivity in Early Childhood: Associations with Child BDNF Genotype and Parenting Style". Biology Graduate Research Forum. Western University. October 2nd, 2010.

RESEARCH: PEER REVIEWED PRESENTATION (POSTERS)

Kryski, K. R., Dougherty, L. R., Sheikh, H. I., Singh, S. M., Klein, D. N., & Hayden, E. P. (2014). Maternal Depression and Cortisol Reactivity in Early Childhood: Longitudinal Associations with Child Symptoms. *A Multi-Site Study*. Accepted for presentation at the 2014 Annual Meeting of the Society for Research in Psychopathology, Evanston, IL.

Ouellete, S. J., Russel, E., **Kryski, K. R.,** Sheikh, H., Singh, S., Koren, G., & Hayden, E. P. (2014). Hair cortisol concentrations in low- and high-stress mother-daughter dyads: A pilot study of associations and moderators. Accepted for presentation at the 2014 Annual Meeting of the Society for Research in Psychopathology, Evanston, IL.

Kryski, K. R., Smith, H. J., & Hayden, E. P. (September 2013). Temperamental Emotionality and Effortful Control in Preschool-Aged Children: Associations with Parental Depression. Poster presented at the 2013 Annual Meeting of the Society for Research in Psychopathology, Oakland, CA.

Sheikh, H. I., Joannisse, M.F., Mackrell, S.V., **Kryski, K.R.,** Smith, H.J., Singh, S.M., Hayden, E.P. (June 2013). White matter microstructure is associated with the Hypothalamic-Pituitary-Adrenal axis reactivity in young girls. Poster presented at the Canada-Israel Symposium on Brain Plasticity, Learning and Education, London, ON.

Kryski, K. R., Smith, H.J., Sheikh, H.I., Singh, S.M., & Hayden, E.P. (2013, April). Child oxytocin receptor (OXTR) genotype and observed parenting behavior: Mediation by negative child behavior. Poster presented at the 2013 Biennial Meeting of the Society for Research in Child Development, Seattle, WA.

Kotelnikova, Y., Olino, T.M., **Kryski, K.R.,** Smith, H.J., Hayden, E.P., & Klein, D.N. (2013, April). Revising the Children's Behavior Questionnaire (CBQ): Item-response and factor analyses. Poster presented at the 2013 Biennial Meeting of the Society for Research in Child Development, Seattle, WA.

Kryski, K. R., Smith, H.J., Sheikh, H.I., Singh, S.M., & Hayden, E.P. (2012, October). Life Stress and Parenting: Associations with HPA Axis Reactivity in Early Childhood. Poster presented at the 2012 Annual Meeting of the Society for Research in Psychopathology, Ann Arbor, MI.

Mackrell, S. V. M., Sheik, H. I., Singh, S. M., **Kryski, K. R.,** & Hayden, E. P. (2012, October). Cognitive Vulnerability and Stressful Life Events Predicting HPA Axis Reactivity in Middle Childhood. Poster presented at the 2012 Annual Meeting of the Society for Research in Psychopathology, Ann Arbor, MI.

Kryski, K. R., Smith, H.J., Sheikh, H.I., Singh, S.M., & Hayden, E.P. (2012, March). Maternal Depression and Parenting: Associations with HPA Axis Reactivity in Early Childhood. Poster presented at the 2012 Annual Meeting of the American Psychopathological Association, New York, NY.

Sheikh, H. I., **Kryski, K. R.,** Smith, H. J., Hayden, E. P. & Singh, S. M. (2012, March). Genetic Variants of The Corticotropin-Releasing Hormone System Related Genes are Associated with HPA Axis Reactivity in Early-Childhood. Poster presented at the 2012 Annual Meeting of the American Psychopathological Association, New York, NY.

Sheikh, H.I., **Kryski, K.R.**, Smith, H.J., Hayden, E.P., Singh, S.M. (2011, October). Neurogenetic correlates of early-age physiological stress response and its link to early emerging psychopathological risk: A prospective study. Poster presented at the 12th International Congress of Human Genetics, Montreal, QC.

Kryski, K. R., Smith, H., Sheikh, H., Singh, S., & Hayden, E. (2011, March). Child BDNF Genotype and Parenting Style: Associations with HPA Axis Reactivity in Early Childhood. Poster presented at the Society for Research in Child Development's Biennial Meeting in Montreal, QC.

Kryski, K. R., Smith, H., Sheikh, H., Hayden, E., & Singh, S. (2010, May). HPA Axis Reactivity Patterns and Internalizing and Externalizing Symptoms in Early Childhood. Poster presented at the Association for Psychological Science 22nd Annual Convention in Boston, MA.

Kryski, K. R., Mash, E., Ninowski, J., & Semple, D. (2009, April). Maternal Symptoms of ADHD and Maternal Language: Implications for Infant Language Development. Poster presented at the Society for Research in Child Development's Biennial Meeting in Denver, CO.

Kryski, K. R., Campbell, T., Keys, B., & Bacon, S. (2007, November). Implications of State and Trait Rumination on Cardiovascular Responses to Stress. Poster presented at the Undergraduate Student Research Participation in Health and Wellness symposium in Calgary, AB.

ACADEMIC AWARDS AND HONOURS

Date	Award	Institution	Value
2014	Michael-Smith Foreign Study Supplement	Canadian Institutes of Health Research	\$6,000
2011-Present	Vanier Canada Graduate Scholarship	Canadian Institutes of Health Research	\$150,000 (\$50,000 per annum for three years)
2012	CCCHR Joint Trainee Symposium Travel Award	CCCHR and Children's Health Resource Institute	\$600
2011	Marilyn (Pack) McClelland Award in Psychology	University of Western Ontario	\$550
2010	Ontario Mental Health Foundation Doctoral Studentship	Ontario Mental Health Foundation	\$48,000 (\$16,000 per annum for three years)
2010	Distinguished Contribution to the SSCP Student Poster Contest	Society for a Science of Clinical Psychology	\$100
2009	CHRI-QOL Graduate Student	Children's Health Resource Institute	\$11,000

	Support Award		
2009-2010	Western Graduate Research Scholarship	University of Western Ontario	\$8,000
2008-2009	Western Graduate Research Scholarship	University of Western Ontario	\$8,000
2007	Undergraduate Student Research Participation Studentship in Health and Wellness	University of Calgary	\$5,000
2007	Dean's List Recipient – Faculty of Social Sciences	University of Calgary	N/A
2005	Dean's List Recipient – Faculty of Kinesiology	University of Calgary	N/A
2003	University of Calgary Scholar Advantage	University of Calgary	\$3,000

RESEARCH EXPERIENCE AND CLINICALLY RELEVANT EMPLOYMENT

Foreign Study-Visiting Student, University of Stony Brook, Stony Brook Long Island (March – May 2014).

- *Supervisor:* Daniel Klein, Ph.D.
- *Project Funded by the Canadian Institutes of Health Research (CIHR) Michael Smith Foreign Study Supplement*
- Processed and analyzed fMRI resting state data on a sample of 9-year old children as part of a large longitudinal study of temperament and psychopathology risk (NIMH funded project). Developed a large combined data set including bio-psycho-social measures from two pre-existing longitudinal samples: Canadian (N = 409; CIHR funded) and United States (N = 559; NIMH funded); for the purposes of exploring the longitudinal development of internalizing psychopathology from ages 3 through 6.

Psychometrist/Research Assistant, University of Western Ontario, London Ontario (July 2008 – 2014).

- *Supervisor:* Elizabeth Hayden, Ph. D.
- *Project Funded by the Canadian Institutes of Health Research (CIHR)*
- Aided in the direct administration of a large (N = 409 families) longitudinal study of the development of temperament and psychopathology in early to middle childhood. Utilized numerous bio-psycho-social data collection procedures and measures (e.g., genetic, psychophysiological, questionnaire bases, observation based, interview based, etc.) across multiple study waves (age 3 to 6).

Diagnostician, Cardiac Rehabilitation Program Evaluation Study. St. Joseph's Hospital and London Health Sciences Centre. (2010-2014)

- *Supervisor:* Peter Prior, Ph. D., C. Psych.
- Conducted structured clinical diagnostic interviews (Mini-International Neuropsychiatric Interview) with patients entering/exiting the cardiac rehabilitation program to track program efficacy.

Research Assistant, University of Calgary and Canadian Sport Centre, Calgary, Alberta (2007)

- *Employer:* Dave Smith, Ph.D.
- Monitored the SPO2 and FiO2 of national athletes sleeping in altitude tents at the Olympic Oval. Data recording took place at half hour intervals. Duties included maintaining tent and blood oxygen levels at predetermined values and debriefing the athletes in the morning.

Research Assistant, Department of Psychology, University of Calgary, Calgary, Alberta (2006-2008).

- *Supervisor:* Jerilyn Ninowski, Ph.D., C. Psych.; Deborah Semple, M.A.; Eric J. Mash, Ph.D., C. Psych.
- Completed participant recruitment of infants and caregivers within immunization clinics in city of Calgary. Participated in home visits with Dr. Ninowski (then Ms. Ninowski) and coding of parent-child interaction tasks.

Research Assistant, Department of Psychology, University of Calgary, Calgary, Alberta (2007)

- *Supervisor:* Tavis Campbell Ph.D., C. Psych.
- Aided with collection of biological impedance data with undergraduate populations. Analyzed ambulatory heart rate variability data and diary data in a study of trait rumination in depression.

PROFESSIONAL SERVICE: INVITED TALKS AND COMMUNITY LECTURES

Kryski, K. R. Talk Title: *Stress Sensitivity and Well-Being*. Invited Talk. Pediatric Psychology. Children's Hospital – London Health Sciences Centre, London Ontario. February 2014.

Kryski, K. R., Smith, H, Sheikh, H., Hayden, E., & Singh, S. *HPA Axis Reactivity Patterns and Internalizing and Externalizing Symptoms in Early Childhood*. Invited Research Talk. Western University, Clinical Psychology. July 2010.

Kryski, K. R. Talk Title: *Sensitivity to Stress-Individual Differences and Implications*. Finding your way: the fifth annual lecture series in the psychology of the everyday life. Central Library, London Ontario. February 2012

Kryski, K. R. Talk Title: *Stress and Well-Being*. Finding your way: the fourth annual lecture series in the psychology of the everyday life. Central Library, London Ontario. February 2011.

Kryski, K. R. Talk Title: *Monkey See Monkey Do: How a parent's behavior influences the child*. Finding your way: the third annual lecture series in the psychology of the everyday life. Central Library, London Ontario. February 2010.

Kryski, K. R. Talk Title: *Healthy Living for Kids: The Importance of Nutrition and Exercise*. Finding your way: the second annual lecture series in the psychology of the everyday life. Central Library, London Ontario. February 2009.

PROFESSIONAL SERVICE: TEACHING AND SUPERVISION EXPERIENCE

Teaching Assistantships:

- Clinical Assessment Practicum. Clinical Psychology Graduate Program. Course #9800 (2013-present)
- Abnormal Child Psychology. Psychology Undergraduate Program. Course #2320 A/B (2012-2013)
- Child Psychopathology. Psychology Undergraduate Program. Course #3320G (2010)
- Drugs and Behaviour. Psychology Undergraduate Program. Course #2020A (2009)

Academic Lectures:

- *Introduction to child measures: Achenbach and Conners assessment systems* (2013). Clinical Psychology Graduate Program. Course #9800.
- *Introduction to the Wechsler Intelligence Scale for Children Fourth Edition (WISC-IV) and the Wechsler Preschool and Primary Scale of Intelligence Fourth Edition (WPPSI-IV)* (2013). Clinical Psychology Graduate Program. Course #9800.
- *Hypothalamic-Pituitary-Adrenal Axis Activity and Internalizing Disorders* (2010). Psychology Undergraduate Program. Course #3320G.
- *Attention-Deficit/Hyperactivity Disorder* (2010). Psychology Undergraduate Program. Course #3320G.
- *Introduction to Models and Principles of Developmental Psychopathology* (2010). Psychology Undergraduate Program. Course #3320G.

Supervision Experiences:

Honors Thesis Research Co-Advisor with Dr. Elizabeth Hayden, University of Western Ontario Thesis title: *Associations between behavioral inhibition and parent reported symptoms in early childhood: Moderation by child sex*. Western psychology honors program thesis based. Student: Michelle Dzialakiewicz (2013 - 2014).

Scholars Elective Student Research Program Assistant Advisor to Dr. Elizabeth Hayden Thesis title: *Associations between the BDNF Val66Met Polymorphism and Child Behavior*. Student: Caitlin Kelly (2012-2013).

Honors Thesis Research Assistant Advisor to Dr. Elizabeth Hayden, University of Western Ontario Thesis title: *Maternal Internalizing Psychopathology, Parenting, and Cortisol Reactivity in Children*. Western psychology honors program thesis based. Student: Joanne Lui (2012 - 2013).

Honors Thesis Research Assistant Advisor to Dr. Elizabeth Hayden, University of Western Ontario Thesis title: *Emotion Regulation and Stress Reactivity in Preschool-Aged Children*. Western psychology honors program thesis based. Student: Rachel Nott (2011 - 2012).

Honors Thesis Research Assistant Advisor to Dr. Elizabeth Hayden, University of Western Ontario *Thesis title: A Multi-Method Association Study of the Relationship between Parenting and Child Psychopathology.* Western psychology honors program thesis based. Student: Sabrina Dilonardo (2009 – 2010).

PROFESSIONAL SERVICE: VOLUNTEER WORK AND COMMUNITY SERVICE

Advocacy Through Action (AtoA, 2008 – 2014)

- AtoA is a clinical psychology graduate student-run initiative that strives to make research and resources on psychological issues available to the community. Each year our group offers a series of public lectures on various topics related to mental health and well-being. In addition to being an active member since 2008 I have also held the following leadership positions:
- **Co-president (2012-2013):** Responsible for overseeing the duties of various AtoA committees, coordinating AtoA members and meetings; applying for external funding to purchase materials; liaising with the library regarding scheduling of the series; organizing topics and schedules of speakers.

Society for Research in Psychopathology (SRP) – Publication Committee (student member) (2012)

- Interviewed the SRP early career award winner, Dr. June Gruber, and completed an article outlining her research and interests for a student driven publication.

Western University Graduate Student Bursary Committee (2009 – 2013)

- Meet three times annually to review and evaluate Canadian and foreign student graduate student bursary applications. Choose awardees based on financial need, life circumstances, and contribution to the Western community.

Western University Clinical Psychology Colloquium Committee (2008-2010)

- Assisted in organizing and hosting invited speakers in the areas of clinical and experimental psychology from Canada and the U.S.A.

Thames Valley Children's Center – Ability Connections Program (2010 – 2014)

- Ability Connections is a group of young people with disabilities who through public speaking aim to increase public awareness of "Abilities" and "Possibilities". They share their stories and experiences with students, teachers, parents and other community groups. As a volunteer I meet with the youth once per month to help them with speech writing and speaking skills.

PROFESSIONAL SERVICE: REVIEWER

2012-present

Primary ad-hoc reviewer for the following journals:

PLOS ONE
 Developmental Psychobiology
 Journal of Hormones
 Current Neuropharmacology
 Developmental Science

Social Development

- 2014 Participation in reviews with Dr. Daniel Klein (Stony Brook University) for the following journals:
Journal of Abnormal Psychology
- 2008-2013 Participation in reviews with Dr. Elizabeth Hayden (University of Western Ontario) for the following journals:
Development and Psychopathology
Health Psychology
Journal of Abnormal Psychology
Clinical Child and Family Psychology Review
Behavior Therapy

MEMBERSHIP IN PROFESSIONAL SOCIETIES

- 2013-present Canadian Psychological Association
2013-present Ontario Psychological Association
2012-present American Psychological Association
2012-present American Psychopathological Association
2011-present Society of Research in Psychopathology
2011-2012 Society for Psychophysiological Research
2009-present Association for Psychological Science
2008-present Society for a Science of Clinical Psychology