MATERNAL HISTORY OF CHILDHOOD ADVERSITY AND EMOTION REGULATION: ASSOCIATIONS WITH CORTISOL REACTIVITY, ATTENTION BIAS, AND OFFSPRING BEHAVIOUR PROBLEMS
MATERNAL HISTORY OF CHILDHOOD ADVERSITY AND EMOTION REGULATION: ASSOCIATIONS WITH CORTISOL REACTIVITY, ATTENTION BIAS, AND OFFSPRING BEHAVIOUR PROBLEMS

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TITLE: Maternal History of Childhood Adversity and Emotion Regulation: Associations with Cortisol Reactivity, Attention Bias, and Offspring Behaviour Problems

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Lay Abstract

Adults exposed to adversity during childhood may experience persistent difficulties regulating their emotional responses. The emotion regulation system is important for modulating physiological and behavioural responsivity to social-emotional challenges, and one of line evidence suggests that this system may undergo changes during the transition to parenthood. This dissertation seeks to examine the enduring influence of childhood experiences on maternal emotion regulation capacity, and the implications of this association for maternal responsivity profiles and offspring behaviour. I address three primary objectives in order to evaluate the consequences of difficulties with emotion regulation in mothers exposed to a range of childhood experiences. Specifically, using data from two cross-sectional designs, I examine: 1) differences in emotion regulation and cortisol reactivity in postpartum women reporting greater exposure to childhood adversity, 2) differences in emotion regulation and attentional bias to emotional stimuli in postpartum women reporting greater exposure to childhood adversity, and 3) differences in emotion regulation and offspring behaviour problems in mothers reporting greater exposure to childhood adversity. Collectively, the results from this dissertation indicate that difficulties with emotion regulation are likely to manifest in mothers as a long-term sequelae of childhood adversity, and demonstrate the need for research evaluating the effectiveness of interventions targeting emotion regulation for families exposed to early adversity.
Abstract

Using cross-sectional data from two larger longitudinal research projects, this dissertation seeks to examine the enduring influence of childhood experiences on maternal emotion regulation capacity, and the implications of this association for maternal responsivity profiles and offspring behaviour. The first cross-sectional design included 140 mothers who were recruited as part of a larger longitudinal study examining the associations between postpartum mood and biological factors. During a home-visit at 6-months postpartum, mothers completed questionnaires which assessed their self-report of childhood trauma, postpartum depressive symptomology, emotion regulation, and sociodemographic variables. Additionally, women completed a challenging Emotional Stroop task, and provided three (baseline, 20-minutes post challenge, and 40-minutes post challenge) salivary samples which were anchored around this task. The salivary samples were later assayed for cortisol and the Emotional Stroop paradigm was scored for attention bias. Structural equation models were constructed to examine if a latent variable of maternal emotion regulation capacity served as a moderating variable in the associations between maternal history of childhood trauma and i) cortisol reactivity, and ii) attention bias. The results revealed that maternal difficulties with emotion regulation significantly moderated the aforementioned associations, such that mothers reporting greater exposure to childhood trauma and more difficulties with emotion regulation displayed i) decreased cortisol reactivity, and ii) attentional avoidance of negative and attachment-related emotional stimuli. The second cross-sectional design included 105 mothers who were recruited as part of a longitudinal study examining the associations
between maternal executive processes and parenting. During a home-visit at 38-months postpartum, mothers completed questionnaires which assessed their self-report of childhood adversity, depressive symptomology, emotion regulation, and child behaviour problems. Latent variable mediated structural equation models were constructed to examine if maternal emotion regulation capacity served as a mediating variable in the association between maternal history of childhood adversity and offspring i) internalizing behaviour problems, and ii) externalizing behaviour problems. The results indicated that the latent variable of maternal difficulties with emotion regulation fully mediated the associations between maternal exposure to childhood adversity and offspring behaviour problems. Specifically, mothers reporting greater exposure to childhood adversity and more difficulties with emotion regulation had young children with greater i) internalizing behaviour problems, and ii) externalizing behaviour problems. These collective results indicate that difficulties with emotion regulation are likely to manifest in mothers as a long-term sequelae of greater exposure to childhood adversity, and demonstrate the need for research evaluating the effectiveness of interventions targeting emotion regulation for families exposed to early adversity.
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First and foremost, I would like to express my immense gratitude to my supervisor Dr. Andrea Gonzalez for her support, advice, and mentorship over the past seven years. I would also like to thank Dr. Benicio Frey, Dr. Geoffrey Hall, and Dr. Margaret McKinnon for their thoughtful guidance over the course of my graduate career. Additional thanks are due to Dr. Leslie Atkinson, Dr. Jennifer Khoury, and Dr. Harriet MacMillan for their collaborations and invaluable insight.

I am grateful to the other members of our research team at the Offord Centre for Child Studies, who fostered my passion for research, provided endless opportunities for growth, and nurtured my development as an independent scientist. Furthermore, I would like to extend my sincerest thanks to the families who participated in our studies and made this research possible.

Finally, special credit goes to the members of my family and extended family. I would like to dedicate this dissertation to this exceptional support network of individuals who provided me with the inspiration and fortitude to complete this work.
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Declaration of Academic Achievement

This thesis is comprised of three studies that were conceptualized and written by the student. This work involves the use of cross-sectional data stemming from larger longitudinal designs developed by the student’s thesis supervisor, Dr. Andrea Gonzalez. For the components pertaining to this dissertation work, the student was involved in the development of study design, creation of protocol, and collection of data. The student independently analyzed the data, prepared the manuscripts, and made revisions based on the suggestions and feedback of her co-authors. All of this work was completed between September 2014 and April 2018. As part of the requirements of a ‘sandwich’ thesis, the contributions of the co-authors in each study are listed below.

Study 1 examined difficulties with emotion regulation as a moderating variable in the association between maternal history of childhood trauma and cortisol reactivity to challenge. It was co-authored by Dr. Andrea Gonzalez, who is principal investigator of the larger longitudinal project and critically reviewed the manuscript to ensure it was ready for publication. It was also co-authored by two members of the Offord Centre for Child Studies at McMaster University, Dr. Melissa Kimber and Dr. Harriet MacMillan, the former who was consulted in regards to the structural equation modeling analyses and both of which critically reviewed the manuscript. Additionally, it was also co-authored by two members of Ryerson University, Dr. Leslie Atkinson and Dr. Jennifer Khoury, who provided expertise on the computerized Emotional Stroop paradigm and also critically reviewed the manuscript.
Study 2 examined difficulties with emotion regulation as a moderating variable in the association between maternal history of childhood trauma and cortisol reactivity to challenge. This study was co-authored by Dr. Andrea Gonzalez, who is principal investigator of the larger longitudinal project and critically reviewed the manuscript and made revisions to ensure it was ready for publication. It was also co-authored by two members of the Offord Centre for Child Studies at McMaster University, Dr. Geoffrey Hall and Dr. Harriet MacMillan, who critically reviewed the manuscript. Additionally, this study was also co-authored by two members of Ryerson University, Dr. Leslie Atkinson and Dr. Jennifer Khoury, who provided expertise on the computerized Emotional Stroop paradigm and also critically reviewed the manuscript.

Study 3 examined difficulties with emotion regulation as a mediating variable in the intergenerational association between maternal history of childhood adversity and offspring behaviour problems. This study was co-authored by Dr. Andrea Gonzalez, who is principal investigator of the larger longitudinal project and critically reviewed the manuscript. It was also co-authored by Dr. Leslie Atkinson of Ryerson University and Dr. Harriet MacMillan of the Offord Centre for Child Studies at McMaster University, who provided thoughtful insight on the theoretical rationale and critically reviewed the manuscript.
Chapter 1

Statement of Purpose

The purpose of this dissertation is to propose and evaluate a conceptual model linking maternal history of childhood adversity to current emotion regulation capacity, in order to examine the implications of this association on adult responsivity profiles and offspring behavioural development. Initially, I propose that a latent construct of maternal difficulties with emotion regulation serves as a vulnerability factor in the association between postpartum women’s history of childhood trauma and current stress responsivity profile (i.e., hypothalamic-pituitary-axis activity, attentional processing of social-emotional information). In the first study, I examine the impact of this conceptual model on postpartum women’s cortisol reactivity to psychosocial challenge. In the second study, I examine the impact of this conceptual model on postpartum women’s attention bias to negative and attachment-related emotional stimuli. In both of these studies I utilize latent variable moderated structural equation models to examine these relationships. Thereafter, in extension of these two previous investigations, I also propose that maternal emotion regulation capacity serves as a mechanism that transmits risk to offspring behavioural development following maternal exposure to childhood adversity. In the third study, I explore the associations between maternal childhood experiences, a latent variable of emotion regulation capacity, and offspring behaviour problems. In this study, I employ a series of path analyses to test my conceptual model. The relevant associations between the main concepts are reviewed in the first chapter of
this dissertation, and the following three chapters describe each of the three studies. The final chapter comprises a general discussion of the main findings of each study and their collective implications for future intervention efforts.

**Chapter 1.1: Childhood Adversity**

1.1.a. *Definition and Prevalence of Childhood Adversity*

Experiences of adversity during childhood represent a ‘pathogenic relational environment’, which confers significant vulnerability for maladaptations to psychological and biological systems (Cicchetti, 2016). Adverse childhood experiences encompass a variety of stressful and traumatic events, including exposure to the subtypes of child maltreatment and household dysfunction (Anda et al., 2006; Felitti et al., 1998). Child maltreatment is defined as any exposure to emotional abuse, physical abuse, sexual abuse, emotional neglect, or physical neglect that results in actual or potential harm to a child’s development (Cicchetti, 2016; Gilbert et al., 2009). In a broader context, household dysfunction is defined as any childhood exposure to parental loss (i.e., separation or divorce), parental mental illness, parental substance abuse, or family violence (Anda et al., 2006; Felitti et al., 1998). Although these types of traumatic events are divisible, it is not rare for a child to experience multiple forms of adversity (Anda et al., 2006; Hughes et al., 2017). This represents a significant problem, as 47-59% of adults report exposure to at least one form of childhood adversity (Bellis, Lowey, Leckenby, Hughes, & Harrison, 2014; Gilbert et al., 2015).
Following the recent trends in the childhood trauma literature to increasingly consider a variety of adverse events and given the constraints of study protocol, the first two analyses of my thesis evaluate maternal retrospective reports of childhood maltreatment through use of the Childhood Trauma Questionnaire (CTQ; Bernstein & Fink, 1998), and my third analysis evaluates maternal retrospective reports of childhood adversity through use of the CTQ and items from the National Comorbidity Survey (NCS-R; Kessler et al., 2004).

1.1.b. Childhood Adversity and Health

Experiences of childhood trauma are linked with adverse pediatric and adolescent health outcomes, including differences in physical development (i.e., shorter height, later age of menarche), cognitive delays, and increased rates of infections and illnesses (Flaherty et al., 2013; Oh et al., 2018). Exposure to childhood adversity is also related to biological changes, including neuroendocrine dysfunction (i.e., cortisol dysregulation), alterations in inflammatory and immune responses, automatic nervous system dysregulation (i.e., maladaptive respiratory sinus arrhythmia activity), and accelerated telomere erosion (Ehlert, 2013; Flaherty et al., 2009; Oh et al., 2018). Furthermore, adversities experienced during childhood can have lifelong consequences by affecting the foundations of physical and emotional health (Bellis et al., 2014; Oh et al., 2018; Shonkoff et al., 2012). In adulthood, retrospective reports of childhood adversity are robustly associated with increased rates of socioeconomic deprivation, health-harming behaviours (e.g., smoking, obesity, etc.), chronic health conditions (e.g., respiratory
disease, cancer, diabetes, stroke, etc.), and mental health disorders (e.g., depression, anxiety disorders, etc.) (Afifi et al., 2016; Bellis et al., 2014, 2015; Gonzalez et al., 2012; Tomasdottir et al., 2015). Overall, these changes illustrate how childhood experiences can become biologically embedded, and how childhood adversity can lead to enduring psychobiological changes across the lifespan (Berens, Jensen, & Nelson, 2017; Ehlert, 2013).

1.1.c. Theoretical Frameworks of Toxic Stress

The aforementioned body of work examining the associations between childhood adversity and developmental outcomes has generated two converging theoretical frameworks describing how toxic stress, the chronic activation of the stress response system, contributes to health and disease across the lifespan (Del Giudice, 2014; McEwen, 2006; Shonkoff et al., 2012). Within an ecobiodevelopmental framework, adult health outcomes are shaped by a complex interplay between genetic, social, and biological factors during early development (Ehlert, 2013; Shonkoff et al., 2012). Allostatic systems are crucial for maintaining homeostasis amidst conditions of stress, with allostasis being defined as the physiological changes through which an individual attempts to return to an optimal state of stability in response to challenges (McEwen & Stellar, 1993). The Allostatic Load Model (ALM; McEwen & Stellar, 1993; McEwen, 2002b, 2006) explains the short-term benefits of allostatic mechanisms and how the long-term ‘wear and tear’ of stressful experiences can predispose an individual to disease. Within the ALM, a range of systems mediate allostasis, including neural, endocrine,
cardiovascular, autonomic, immune, and metabolic processes (Hostinar & Gunnar, 2013; McEwen, 2008). Repeated allostatic adjustments across these systems take a toll on the body, eventually contributing to the development of mental and physical illnesses (McEwen & Stellar, 1993; McEwen, 2006). Thus, chronically stressful childhood environments can lead to allostatic overload (McEwen & Wingfield, 2003), which contributes to persistent health disparities following childhood adversity (Danese & McEwen, 2012; Lupien, McEwen, Gunnar, & Heim, 2009; McEwen, 2008).

Relatedly, the *Adaptive Calibration Model* (ACM; Del Giudice, Ellis, & Shirtcliff, 2011) takes an evolutionary-developmental approach to explaining stress reactivity. The ACM describes how individual differences in stress responsivity are largely the result of adaptive mechanisms that serve to maintain allostasis in response to physical and psychological challenges, encode and filter information from the social and physical environment, and regulate physiology and behaviour (Del Giudice et al., 2011). The resulting traits and behaviours of these conditional adaptations are viewed as components of an individual’s life history strategy, a biological construct which defines an individual’s developmental trajectory and allocation of time and energy (Belsky, Schlomer, & Ellis, 2012; Del Giudice et al., 2011). Additionally, the ACM describes sex differences in life history strategies and how they are impacted by stressful childhood contexts (Del Giudice et al., 2011). Compared to the ALM, the ACM provides a comprehensive account of how the stress-response-system affects a variety of physiological systems and behaviours (Hostinar & Gunnar, 2013). Notably, this includes the influences of individual stress responsivity profiles on learning, attachment, risk-
taking, competition, reproduction, and parental investment (Del Giudice et al., 2011; Hostinar & Gunnar, 2013). One additional strength of this model is that it allows for the explanation of changes in stress responsivity across development, such that programming of this system based on early childhood adversity may be recalibrated later in life in order to accommodate changes in environmental conditions (Hostinar & Gunnar, 2013).

1.1.d. Current Recommendations for Research

Although considerable research has examined the associations between childhood adversity and health outcomes, as well as the biological mechanisms that underlie these associations, recent insights still need to be utilized to tailor interventions and transform healthcare models (Berens et al., 2017). Prevention scientists have evaluated a multitude of family-based and school-based interventions for preventing and reducing childhood adversity, as well as early screening and assessment tools to help evaluate and treat the consequences of exposure to early adversity (Biglan, Van Ryzin, & Hawkins, 2017). However, only limited research has examined the influence of childhood adversity on adults during the transition to parenthood, especially in regards to the intergenerational transmission of risk (Biglan et al., 2017; Madigan, Wade, Plamondon, Maguire, & Jenkins, 2017; Plant, Jones, Pariante, & Pawlby, 2017). This is an important extension, as research examining the impact of childhood adversity on new parents and the next generation will help inform preventative intervention programs for families. Therefore, the objective of this thesis is to investigate the implications of the association between
maternal exposure to childhood adversity and emotion regulation capacity on neuroendocrine reactivity, attentional processing, and offspring behaviour.

Chapter 1.2: Emotion Regulation

1.2.a. Overview of Emotion and Emotion Regulation

Emotions are described as psychological states that integrate subjective experiences, behavioural changes in the activity of muscles of the face and body, and autonomic and neuroendocrine responses (Barrett, Gendron & Huang, 2009; Levenson, 1999). Despite the vast heterogeneity in the intensity and duration of emotions, they are characterized by three core features: i) emotions arise during situations that are relevant to goal-driven processes, ii) emotions involve the coupling of multiple psychological states and bodily systems, and iii) emotions are sensitive to internal and external environmental conditions (Barrett, Gendron, & Huang, 2009; Gross, Sheppes, & Urry, 2011). Based on these three defining core features, emotions are complex states that gradually unfold, and thus require dynamic and effortful regulation (Gross, 2002; Gross & Barrett, 2011; Thompson, 2008). Broadly, emotion regulation is defined as the essential processes for monitoring, evaluating, and modifying emotional expressions and experiences (Thompson, 2008). Emotion regulation is conceptually described as a biopsychosocial behavioural system responsible for the activation, modulation, and inhibition of emotional reactions (Rothbart & Sheese, 2007). This emotion regulation system coordinates the magnitude and duration of both physiological and behavioural responses in order to
accomplish goals and social-emotional objectives (Gross & Thompson, 2007; Rothbart & Sheese, 2007).

1.2.b. Models of Emotion Regulation

Leading theorists have conceptualized that emotion regulation is initiated through the intention to modify emotion generation and then followed by recruitment of one or more processes that influence the nature of emotional response (Gross et al., 2011; Gross & Thompson, 2007). The Process Model defines emotion regulation by strategies that can be broadly differentiated based on whether they act on the antecedent of an emotion or the emotional response itself (Gross, 1998). An example of an antecedent-focused strategy is cognitive reappraisal, where cognitive effort is employed to modify the interpretation of a situation before an emotional response is generated (i.e., attempting to think about a potentially emotional event in non-emotional terms) (Gross, 1998, 2002). Conversely, an example of a response-focused strategy is expressive suppression, where a behavioural attempt is made to reduce or attenuate an emotional response that is already underway (i.e., hiding an emotional outburst to a distressing event) (Gross, 2002; Gross & Levenson, 1993). Within this model, antecedent-focused strategies are often considered adaptive; whereas response-focused strategies are generally viewed as maladaptive, given that these strategies have been linked to higher incidences of mood disorders and emotional difficulties (Aldao, Nolen-Hoeksema, & Schweizer, 2010; Gross, 1998; Haga et al., 2012).
Alternatively, the *Multidimensional Emotion Dysregulation Model* defines effective emotion regulation by global abilities that include understanding emotions, accepting negative emotions, behaving according to desired goals, controlling impulsivity, and using contextually-appropriate emotion regulation strategies (Cole, Michel, & Teti, 2008; Gratz & Roemer, 2004; Thompson et al., 1996). This structure seeks to assess the multifaceted nature of emotion regulation across the processes of emotion generation and regulation (Gratz & Roemer, 2004). Within this framework, emotion dysregulation comprises deficits in the awareness and understanding of emotional experience, non-acceptance of negative emotions, limited access to strategies that effectively manage emotions, and the inability to regulate impulsivity and accomplish goals (Gratz & Roemer, 2004; Linehan, 1993; Melnick & Hinshaw, 2000). In line with previous work on maladaptive emotion regulation strategies, these global dimensions of emotion dysregulation are also associated with the development and maintenance of multiple forms psychopathology (Aldao et al., 2010; Dixon-Gordon, Aldao, & De Los Reyes, 2014).

Research often diverges based on the investigation of a specific conception of emotion regulation, considering either the Process Model through use of the Emotion Regulation Questionnaire (ERQ; Gross & John, 2003) or the Multidimensional Emotion Dysregulation Model through use of the Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004). Research increasingly advises that the Process Model is too simplistic, as specific emotion regulation strategies are often context-dependent and adaptive emotion regulation requires flexibility and more global skills (Cole et al., 1994;
Dixon-Gordon, Aldao, & De Los Reyes, 2015). Consequently, it is recommended that more nuanced and encompassing methods are needed to study the broad psychological concept of emotion regulation (Aldao, 2013; Bonanno & Burton, 2013). Recent evidence suggests that the ERQ and DERS assess distinct, but related, facets of emotion regulation; as the ERQ assesses use of specific strategies that allow individuals to modify their emotional responses, and the DERS measures general ability to strategically regulate emotions (Barden & Fergus, 2014; Zelkowitz & Cole, 2016). Thus, integrating these two models of emotion regulation may allow for a more inclusive assessment of the regulatory processes that modify emotion generation and the executive processes that strategically control emotions. Previous studies on borderline personality disorder (Salsman & Linehan, 2012) and pathological gambling (Williams, Grisham, Erskine, & Cassedy, 2012) have studied difficulties with emotion regulation as cumulatively determined by these two measures. In line with these approaches, this dissertation evaluates ‘difficulties with emotion regulation’ across these two perspectives.

1.2.c. The Neurobiology of Emotion Regulation

Over the past two decades, the regulation of emotion has been of great interest to the scientific community; however, confusion remains about the nature and division between processes that constitute an emotional response and its regulation (Cole, Martin, Dennis, Marin, & Dennis, 2004; Gross, 2013; Gross & Barrett, 2011; Sheppes, Suri, & Gross, 2015). From the basic emotion perspective, an emotion is defined as a biological entity caused by a specific brain circuit or affect program, and emotion regulation refers
to the cortical modulation of subcortical emotion circuits that prevent or alter emotional responses (Lewis, 2005; Panksepp, 1998). Thus, neural perspectives of emotional regulation focus on the interaction between the bottom-up processes of emotional appraisal in subcortical regions and the top-down processes of cognitive control in various prefrontal systems (Ochsner & Gross, 2008). Subcortical mechanisms, such as the amygdala, are involved in evaluating incoming sensory input on emotional features (Hariri et al., 2000; Hariri et al., 2003). Whereas top-down processes engage dorsomedial and dorsolateral prefrontal regions in order to generate mental representations of affective states and initiate executive control to regulate emotions (Beauregard et al., 2001; Ochsner et al., 2002). Furthermore, prefrontal and cingulate systems support emotional control processes in order to modify activity in the posterior and subcortical systems that produce emotional responses, with semantic and perceptual systems serving intermediary roles (Ochsner, Bunge, Gross, & Gabrieli, 2002; Ochsner, Silvers, & Buhle, 2012a; Ochsner & Gross, 2005).

Neuroimaging research has begun to delineate the neural regions supporting specific emotion regulation strategies, with studies on inhibitory control and emotional suppression demonstrating that expressive suppression activates areas in the lateral prefrontal cortex, amygdala, and insula (Garavan, Hester, Murphy, Fassbender, & Kelly, 2006; Kelly, Hester, Murphy, Javitt, & Foxe, 2004; Lee, Dolan, & Critchley, 2007). Conversely, cognitive reappraisal is an emotion regulation strategy that involves more top-down mechanisms, engaging executive control processes that activate regions across the prefrontal cortex and the dorsal anterior cingulate cortex (Beauregard, Levesque, &
Bourgouin, 2001; MacDonald, Cohen, Stenger, & Carter, 2000; Ochsner, Bunge, Gross, & Garieli, 2002). Outlining the distinction between the generation and regulation of emotional responses is challenging, as many of the processes involved in both engage similar attention and appraisal mechanisms (Gross & Thompson, 2007; Kappas, 2011; Thompson, 2011), as well as overlapping neural architecture (Ochsner et al., 2002; Ochsner & Gross, 2007; Ochsner, Silvers, & Buhle, 2012a). As effective emotion regulation encompasses many interrelated prefrontal and subcortical processes it is important to consider various manifestations of emotional processes, and dysfunction in these interrelated processes is highly related to emotional disorders (Aldao & Nolen-Hoeksema, 2013; Ochsner, Silvers, & Buhle, 2012b).

1.2.d. Emotion Regulation and Childhood Adversity

Children exposed to early adversity are at an increased risk for social-emotional development issues (Luke & Banerjee, 2013; McCrory, De Brito, & Viding, 2010). Specifically, children exposed to chronic stress, abuse, and/or neglect can exhibit difficulties regulating their physiological and behavioural responses to emotional information (Lupien et al., 2009; Pollak, 2008). Stressful environments cause frequent arousal, and as a consequence, children are often unable to effectively monitor their reactions and regulate their emotions (Dodge, Pettit, Bates, & Valente, 1995; Ford, Fraleigh, & Connor, 2009). Research shows that exposure to child maltreatment is associated with lower tolerance for negative emotions, as well as greater utilization of avoidant and response-focused emotion regulation strategies (Luke & Banerjee, 2013;
Pollak & Tolley-Schell, 2003). In terms of brain activity, child maltreatment is associated with increased activation in the neural regions that detect salient cues in the environment, such as the amygdala, in response to negative emotional stimuli (McLaughlin, Peverill, Gold, Alves, & Sheridan, 2015). During childhood these alterations in emotional responses and neural activity may represent an adaptation to a stressful environment, but these changes may manifest as emotional dysregulation in adulthood (Pollak, 2008; Thompson, Hannan, & Miron, 2014).

Research shows that adults exposed to childhood adversity can experience difficulties regulating their emotional expressions and experiences (Cloitre, Stovall-McClough, Zorbas, & Charuvastra, 2008; Paivio & Laurent, 2001; Shipman, Edwards, Brown, Swisher, & Jennings, 2005). The capacity to modulate emotional responses is especially important in parenthood, as during caregiving contexts emotion regulation serves unique functions, and parents must endeavor to maintain effective self-regulation while facilitating regulation in their child (Rutherford, Wallace, Laurent, & Mayes, 2015). The lack of research examining these associations in parents exposed to childhood adversity denotes a research gap, as models of at-risk parenting advocate the importance of conducting further research on the processes of emotion regulation in parents vulnerable to emotional dysfunction (Teti & Cole, 2011). Further discussion of the functional capacity and implications of emotion regulation during parenthood are examined in Chapter 1.5.
Chapter 1.3: The Hypothalamic-Pituitary-Adrenal (HPA) Axis

1.3.a. The HPA Axis and Stress

The hypothalamic-pituitary-adrenal (HPA) axis is part of neuroendocrine system and constitutes one of the principle pathways of the mammalian stress response system (Lupien et al., 1998). Through a cascade of interactive processes, the HPA axis controls the release of glucocorticoid hormones including cortisol, which is commonly used as a peripheral marker of HPA axis activity (Karl & Raith, 1966). Exposure to a stressor initially triggers the release of corticotrophin releasing hormone (CRH) and arginine vasopressin (AVP) from the paraventricular nucleus of the hypothalamus (Lupien et al., 1998). In turn, increased levels of CRH and AVP stimulate the secretion of adrenocorticotrophic hormone (ACTH) from the anterior pituitary gland, which acts on the adrenal cortex in order to initiate the synthesis of cortisol (Karl & Raith, 1966; Lupien et al., 1998). Cortisol secretion is necessary for survival; however, elevated cortisol levels (i.e., hyperactivity) or hypoactivity can have deleterious impacts on health (Lupien et al., 1998; Phillips, Ginty, & Hughes, 2013; Staufenbiel, Penninx, Spijker, Elzinga, & van Rossum, 2013). In order to regulate HPA axis activity and restore homeostasis, this hormonal cascade is suppressed by a negative feedback loop, whereby cortisol-activated glucocorticoid receptors inhibit further secretion of CRH from the hypothalamus, thereby preventing subsequent release of cortisol (Lupien et al., 1998). Thus, the HPA axis underlies both adaptive and maladaptive responses to stress, such that adaptive responses involve rapid activation and then inhibition of cortisol secretion, whereas maladaptive
responses comprise dysregulation of this system (de Kloet, Sibug, Helmerhorst, & Schmidt, 2005).

1.3.b. HPA Axis Activity in Infancy and Early Childhood

Throughout childhood, there are changes in the basal activity of the HPA axis and cortisol reactivity (Gunnar & Donzella, 2002; Loman, Gunnar, & The Early Experience, Stress, and Neurobehavioral Development Center, 2010). Newborns do not exhibit the adult rhythm in cortisol production, with the single early morning peak in cortisol secretion typical of adult patterns being reliably established at 3-months of age, and a young child’s daily cortisol rhythm changing over the first few years of life (Gunnar & Donzella, 2002). Healthy human newborns display increases in cortisol and ACTH in response to stressful experiences (e.g., doctor’s examinations/vaccines), and over the first year of life infants begin to exhibit a marked decrease in the responsiveness of the HPA axis, which persists through toddlerhood and the preschool years (Gunnar, Brodersen, Krueger, & Rigatuso, 1996; Larson, White, Cochran, Donzella, & Gunnar, 1998; Lewis & Ramsay, 1995). Typically, toddlers and preschoolers do not exhibit elevated cortisol responses to mildly threatening stimuli (e.g., attending the first day of nursery school), which is described as a period of ‘stress hyporesponsivity’ (Gunnar & Donzella, 2002; Nachmias, Gunnar, Mangelsdorf, Parritz, & Buss, 1996). This hyporesponsivity in young children is theorized to help protect the developing brain from damage caused by elevated levels of adrenocortical hormones (Nachmias et al., 1996; Tarullo & Gunnar, 2006).
The quality of parental care and the social environment have a particularly strong influence on a child’s cortisol reactivity (Brotman, Gouley, Klein, Castellanos, & Pine, 2003; Gunnar & Donzella, 2002; Jaffee et al., 2015). Sensitive and responsive caregiving by the primary attachment figure is presumed to lead to secure attachment (Zimmermann, 1999), which helps young children develop functional glucocorticoid responsiveness to stress, with the caregiver serving as a buffer to the child’s adrenal cortex (Gunnar & Donzella, 2002; Gunnar, Brodersen, Nachmias, Buss, & Rigatuso, 1996). Research has shown that securely attached toddlers do not exhibit cortisol increases when their primary attachment figure is present, but in the absence of a responsive caregiver they are just as prone to cortisol elevations as young infants (Gunnar & Donzella, 2002). Similarly, young children exposed to even moderately less sensitive and responsive care demonstrate increases in cortisol; which is especially evident in children who are temperamentally vulnerable, as indexed by emotional volatility and difficulties with behavioural regulation (Gunnar, 1992; Gunnar, Brodersen, Nachmias, Buss, & Rigatuso, 1996; Nachmias et al., 1996).

1.3.c. **HPA Axis Activity in Adolescence and Adulthood**

Experiences with primary attachment figures continue to have an impact on stress reactivity across middle childhood and adolescence (Hostinar & Gunnar, 2013; Hostinar, Sullivan, & Gunnar, 2014). However, starting around middle childhood the attachment figure does not have to be physically present in order to influence HPA axis response (Hostinar et al., 2014). Adolescence represents a transitional period, as children begin to
progressively shift their reliance on parents as their source of security and attachment, to friends and later romantic partners (Allen & Miga, 2010; Collins, Welsh, & Furman, 2009; Hostinar et al., 2014). This transition is hypothesized to coincide with the loss of a critical stress buffer, as the parent-child relationship no longer serves to shield the developing brain from the consequences of elevated cortisol levels (Gunnar & Hostinar, 2015). This hypothesis is supported by empirical evidence showing that parental support has a diminishing effect on HPA axis activity and recovery across middle childhood and adolescence (Doom, Hostinar, VanZomeren-Dohm, & Gunnar, 2015; Gunnar & Hostinar, 2015; Hostinar, Johnson, & Gunnar, 2015).

HPA axis reactivity is one of the most well-studied neurobiological mechanisms involved in the transduction of insensitive and unresponsive care during childhood on adult risk for psychopathology (Loman et al., 2010; Raymond, Marin, Majeur, & Lupien, 2017; Strüber, Strüber, & Roth, 2014; Tarullo & Gunnar, 2006). Throughout development there are sex differences in HPA axis activity that impact this association, as females generally experience more rapid activation of the HPA axis and estrogens may contribute to neuroendocrine resilience (Goel, Workman, Lee, Innala, & Viau, 2014; McEwen, 2002b). Research indicates that gonadal steroids and their corresponding actions on androgen and estrogen receptors have a major influence on HPA axis activity through their impact on gene expression, protein synthesis, and central nervous system transmission (Gobinath, Mahmoud, & Galea, 2015; Goel et al., 2014; Handa, Burgess, Kerr, & O’Keefe, 1994). The sexual dimorphism of the neural circuits involved in adult stress reactivity begins early in life, as during early development gonadal hormones exert
an organizational influence on the brain, whereas release of gonadal hormones during puberty and adulthood lead to activational differences in HPA function (Arnold & Breedlove, 1985; Goel et al., 2014). In adults, HPA axis dysregulation is linked to the development of various neuropathologies (e.g., depression, anxiety, posttraumatic stress disorder), as well as enduring alterations in immune, cardiovascular, and metabolic function (Arnold & Breedlove, 1985; Staufenbiel et al., 2013). Specifically, the dysregulation of glucocorticoids due to chronic and repeated stress during childhood is noted as a contributing factor in the etiology of adult psychiatric disorders, as well as the sex differences in the prevalence of these disorders (Arnold & Breedlove, 1985; Gobinath et al., 2015; Little, 2013).

1.3.d. HPA Axis Activity and Childhood Adversity

There is considerable individual variation in HPA axis reactivity, and there can be an enduring influence of the early environment and childhood experiences on adult cortisol responses (Heim, Newport, et al., 2000; Kirschbaum & Hellhammer, 1994; van der Vegt, van der Ende, Kirschbaum, Verhulst, & Tiemeier, 2009). Overall, the literature examining exposure to childhood adversity and HPA axis activity reports equivocal findings on the magnitude and direction of this relationship. Maltreated children have been reported to exhibit significant elevations in morning cortisol levels (Dante Cicchetti & Rogosch, 2001; Tarullo & Gunnar, 2006) and higher overall variability in cortisol regulation (Bernard, Frost, Bennett, & Lindhiem, 2017; Doom, Cicchetti, & Rogosch, 2014). Conversely, multiple studies have reported HPA axis blunting in children and
adolescents exposed to maltreatment (Doom et al., 2014; MacMillan et al., 2009; Ouellet-Morin et al., 2011). In adults, history of childhood adversity has been linked to higher levels of awakening and basal cortisol (Dante Cicchetti & Rogosch, 2001; Gonzalez, Jenkins, Steiner, & Fleming, 2009), as well as lower basal cortisol and blunted diurnal cortisol activity (Kuras et al., 2017; Trickett, Noll, Susman, Shenk, & Putnam, 2010; Yehuda, Halligan, & Grossman, 2001). There are also mixed findings on neuroendocrine responsivity in adults exposed to childhood trauma, with some research providing evidence of blunted cortisol reactivity (Bunea, Szentágotai-Tătar, & Miu, 2017; Carpenter, Shattuck, Tyrka, Geracioti, & Price, 2011), and other work suggesting that childhood adversity is linked to increased HPA axis reactivity (Heim et al., 2002).

**Chapter 1.4: Attention Bias**

**1.4.a. Attention to Emotional Information**

Due to the limited mental resources available for attending and processing information, incoming sensory stimuli are appraised and only a portion reach consciousness for further processing (Cohen, Dunbar, & McClelland, 1990; Logan, 1992). Through activation of the autonomic nervous system, the emotionality of incoming stimuli is automatically evaluated (Levenson, 1992; Öhman, Esteves, Flykt, & Soares, 1993). Compared to neutral material, emotional information tends to be processed more extensively and remembered more accurately (Ochsner & Gross, 2005; Pratto & John, 1991). Thus, the direction of individual attention either towards or away
from emotional information reflects personal experience, motivational states, and emotional health (Morales, Fu, & Pérez-Edgar, 2016; Pratto & John, 1991). The preferential processing of emotional information has been termed *attention bias*, specifically defined as the phenomena where affective stimuli cause interference and capture attention more effectively than do neutral stimuli (Pratto & John, 1991). Consequently, individual reaction times are often slower for emotional and personally-relevant cues than for neutral material, resulting in an enhanced interference to those cues (Williams, Mathews, & MacLeod, 1996; Wingenfeld et al., 2006).

1.4.b. Attention and Internal Working Models

Established theory and emerging data lend support to the notion that individual differences in social-emotional processing are significantly influenced by early attachment experiences (Bowlby, 1989; Dykas & Cassidy, 2011; van Emichoven, van IJzendoorn, de Ruiter, & Brosschot, 2003). Attachment relationships with primary caregivers have a major influence on the healthy development of emotional understanding and self-regulation during early childhood (Bowlby, 1989). Attachment theory describes how regulatory functions develop based on early experiences with primary attachment figures, and it is largely within the parent-child relationship that young children learn adaptive or maladaptive social-emotional processing patterns (Bowlby, 1989; Dykas & Cassidy, 2011). Interactions with attachment figures form internal working models, from which infants begin to construct internal representations of the world, and later on these models influence selective attention to attachment-related information (Bowlby, 1982;
Kirsh & Cassidy, 1997). The attachment behavioural repertoire is an adaptive system that provides individuals with both conscious and unconscious rules for directing and organizing the processes of attention and memory (Bowlby, 1982; Mikulincer, Shaver, & Pereg, 2003). Based on early experiences particular environmental cues are more salient, and the attachment relationship modulates arousal and the processing of emotional information (Bowlby, 1989). This has a persistent influence, as research shows that early attachment representations are relatively stable across significant portions of the lifespan and predict adult attachment patterns (Waters, Merrick, Treboux, Crowell, & Albersheim, 2000).

Attachment classification is theorized to underlie the strategic allocation of attention; such that organized attachment represents an attempt to balance attention between the attachment figure and exploration, and disorganized attachment represents the collapse of these strategies under conditions of perceived stress (Atkinson et al., 2009; Lyons-Ruth & Jacobvitz, 1999; Lyons-Ruth & Spielman, 2004). Threatening stimuli activate the attachment system and internal working models filter the incoming information by directing attention (Mikulincer et al., 2003). Within this framework, adaptive responses to affective stimuli result from attachment security, whereas maladaptive responses are associated with attachment insecurity and lead to ineffective social-emotional processing (Bowlby, 1982; Dykas & Cassidy, 2011; Mikulincer et al., 2003). These maladaptive responses are theorized to serve a protective capacity, referred to as defensive exclusion, as they shield an individual from re-experiencing distress by
turning the individual’s attention away from social-emotional information (Bowlby, 1982).

1.4.c. Attention Biases in Adulthood

Extensive research has connected attention biases with clinical conditions like anxiety disorders (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007; Mogg et al., 2000; Wilson & MacLeod, 2003), depression (MacLeod, Mathews, & Tata, 1986; Mogg, Bradley, & Williams, 1995; Pearson, Cooper, Penton-Voak, Lightman, & Evans, 2010), and posttraumatic stress disorder (Bar-Haim et al., 2007; Fani, Bradley-Davino, Ressler, & McClure-Tone, 2011). Attention biases has also been linked to dimensions of attachment in adults (Dewitte, Koster, De Houwer, & Buysse, 2007), and disorganized attachment in mother-infant dyads (Atkinson et al., 2009). Existing theoretical frameworks on selective attention to emotional stimuli and vulnerability for psychopathology propose that attentional function can be shifted based on the perceived threat level of a situation (Mathews & Mackintosh, 1998). For example, both high and low trait anxious individuals will avoid mildly threatening stimuli and attend to extremely threatening stimuli; however, high trait anxious individuals will attend more towards stimuli of an intermediate level because their perception of threat value is different (Mogg et al., 2000; Wilson & MacLeod, 2003). This threat value is assigned by an internal appraisal mechanism, and can cause a shift from attentional avoidance to attentional vigilance, regardless of anxiety vulnerability, when stimuli reach a certain threshold (Bradley, Mogg, Falla, & Hamilton, 1998; Wilson & MacLeod, 2003).
Although derived from separate theoretical ideologies, this internal appraisal mechanism performs similar tasks to the filtration of emotional stimuli by internal working models in the attachment system (Mikulincer et al., 2003). The concept of a representational model is a common thread, as research on the neural substrates of selective attention indicates that emotional salience, as determined by activity in the amygdala and other limbic areas, contributes to an internal sensory representation that serves to modulate attention towards or away affective stimuli (Vuilleumier, 2005).

1.4.d. Attention Bias and Childhood Adversity

Investigation of the associations between attention biases and exposure to childhood adversity has been predominantly examined in survivors of childhood abuse using the dot-probe task. However, this body of research has uncovered mixed results, with some research reporting that child abuse is associated with attentional allocation towards emotional cues (Pollak & Tolley-Schell, 2003), and other work reporting links between childhood trauma and attentional avoidance of emotional stimuli (Pine et al., 2005). Abused children have been found to exhibit attention bias towards facial expressions of anger (Pollak & Tolley-Schell, 2003). Correspondingly, youth and adults with histories of moderate to severe maltreatment also show increased attention to angry and sad faces (Gibb, Schofield, & Coles, 2009). In contrast with these findings, children exposed to maltreatment with current posttraumatic stress disorder display decreased attention bias to threatening faces (Pine et al., 2005), and adults with histories of maltreatment and attachment anxiety also exhibit attentional avoidance of threatening
faces (Davis et al., 2014). Another method of measuring attention bias is by recording participant response latencies during an Emotional Stroop paradigm, a modified version of the Stroop task which evaluates selective attention to emotional words (Atkinson et al., 2009; Williams et al., 1996; Wilson & MacLeod, 2003). A recent study has shown that history of childhood trauma also impacts the processing of neutral, personally-relevant, and emotional stimuli during the Emotional Stroop task (Wingenfeld et al., 2011).

**Chapter 1.5: Intergenerational Transmission of Risk**

1.5.a. *Emotion Regulation in Parenthood*

In order to examine the intergenerational implications of difficulties with emotion regulation, it is important to first consider the role of emotion regulation during parenthood and parenting. During parenthood, emotion regulation refers to a parent’s ability to modulate their emotional experiences and expressions in caregiving situations (Gross, 1998b; Gross & Thompson, 2007). Compared to other time periods and contexts, a parent’s emotion regulation capacity has a unique functional purpose, as it serves to facilitate sensitive and responsive caregiving behaviours (Crandall, Deater-Deckard, & Riley, 2015; Thompson, 2008). Parenting young children involves balancing a variety of competing demands, which may be particularly challenging for parents with deficits in emotion regulation (Crandall, Deater-Deckard, & Riley, 2015). In the face of challenging child behaviours, parents call upon their emotion regulation system in order to appropriately respond to emotional cues, make decisions, and engage in goal-directed
behaviours (Barrett & Fleming, 2011; Crandall et al., 2015b; Morelen, Shaffer, & Suveg, 2014). Parents with effective emotion regulation abilities are more flexible, adaptable, and better able to cope with stress (Morelen, Menke, Rosenblum, Beeghly, & Muzik, 2016; Morelen et al., 2014). Thus, recent research has proposed that the neurobiological, hormonal, and behavioural adaptations during an adult’s transition to parenthood may underlie changes in their emotion regulation, and thus their responses to their child’s cues (Rutherford et al., 2015).

1.5.b. Maternal Emotional Competency, Parenting, and Child Behaviour

Mothers play an important role in their child’s social-emotional development, as primary caregivers directly and indirectly socialize children’s emotional and behaviour responses (Calkins & Fox, 2002; Morris et al., 2011). Research recognizes that maternal emotional competency is an important factor underling young children’s physiological and behavioural regulation, as mother’s model how to manage distress and regulate impulsivity (Calkins, Smith, Gill, & Johnson, 2001). Maternal emotional disorders can have detrimental impacts on the quality of parenting behaviours and mother-child interactions, as well as increase their child’s risk for psychopathology (Goodman et al., 2011; Lovejoy, Graczyk, O’Hare, & Neuman, 2000; Murray, Halligan, & Cooper, 2010). Previous research has demonstrated that mothers who employ negative and controlling strategies for managing their toddlers’ problem behaviours have children with poorer physiological reactivity, less adaptive emotion regulation, and more behavioural difficulties (Calkins, Smith, Gill, & Johnson, 2001). Ultimately, as systematic evidence
reports strong links between emotional control and maternal sensitivity, research has
determined that it is conceptually appropriate to propose that maternal emotion regulation
capacity impacts parenting quality and child behaviour outcomes (Crandall et al., 2015;

The tripartite model of parental influence on children’s behavioural adjustment
states that children first learn social-emotional skills through observing their parents’
regulation of emotions, then parents socialize and reinforce children’s affective processes,
and finally the family emotional climate (e.g., quality of attachment relationship,
parenting style, etc.) provides young children with information about what to expect in
the future (Morris et al., 2007). In this framework, parental emotion regulation capacity
is related to children’s development of internalizing behaviours, externalizing behaviours,
and social competence (Morris et al., 2007; Rutherford et al., 2015). Thus, considering
the impact of maternal emotional competencies on children’s behavioural adjustment may
help identify mechanisms that underlie children’s risk for internalizing and externalizing
problems (Goodman & Gotlib, 1999). In children, internalizing problems include
symptomatology of depression, anxiety, social-withdrawal, and somatic complaints
(Achenbach & Ruffle, 2000). Whereas, externalizing problems include aggression,
impulsivity, and symptomatology of attention-deficit/hyperactivity disorder and conduct
disorder (Hinshaw, 2002). Internalizing behaviours that are present during early
childhood are predictive of later adjustment difficulties in older childhood (Shanahan,
Calkins, Keane, Kelleher, & Suffness, 2014; Sterba, Prinstein, & Cox, 2007). Similarly,
externalizing behaviours that are present during toddlerhood and the preschool years are
robust predictors of more severe behavioural problems during the elementary school years (Campbell, Shaw, & Gilliom, 2000). Therefore, examining potential mechanisms through which mothers influence their preschool children’s behavioural adjustment may help to interrupt the intergenerational transmission of risk and to ameliorate child behavioural problems before they become more firmly entrenched (Campbell et al., 2000; Goodman & Gotlib, 1999; Shanahan et al., 2014).

1.5.c. Maternal History of Childhood Adversity and Offspring Behaviour

Contemporary evidence links childhood adversity with greater risk for emotional disorders during motherhood (Choi et al., 2017; Lang, Rodgers, & Lebeck, 2006; Sperry & Widom, 2013). Recently, a prospective longitudinal study revealed that neither maternal exposure to childhood adversity or emotional dysfunction independently predicted children’s risk for psychopathology; however, children of mothers who reported both childhood adversity and emotional dysfunction were at significantly greater risk for antisocial behaviours and mental health problems during adolescence (Plant, Barker, Waters, Pawlby, & Pariante, 2013). There are various mechanisms that have been previously identified in the intergenerational transmission of risk following maternal history of childhood trauma. Prior research has reported that adult attachment, parenting practices, depressive symptoms, and social support serve as partial mediators of the relationship between maternal history of childhood adversity and offspring development of internalizing and externalizing behaviour problems (Fredland, McFarlane, Symes, & Maddoux, 2018; Koverola et al., 2005; Min, Singer, Minnes, Kim, & Short, 2013;
Pereira, Ludmer, Gonzalez, & Atkinson, 2018). These are notable findings, as the processes of emotion regulation are closely connected to, but distinct from, internal working models of the attachment system (Mikulincer et al., 2003; Waters et al., 2010), and psychopathology (Aldao & Nolen-Hoeksema, 2012; Aldao, Nolen-Hoeksema, & Schweizer, 2010; Sheppes, Suri, & Gross, 2015). Although evidence strongly suggests that maternal difficulties with emotion regulation may transmit risk to child behavioural development following maternal experiences of childhood adversity, to the best of my knowledge, this relationship has never been previously explored.

**Chapter 1.6: Applying the Adaptive Calibration Model (ACM)**

1.6.a. *Phenotypes of the ACM*

The ACM (Del Giudice et al., 2011) delineates four patterns of stress responsivity: sensitive (I), buffered (II), vigilant (III), and unemotional phenotypes (IV). Broadly, this model describes a nonlinear relationship between the magnitude of environmental stress present during childhood and the resulting optimal level of stress reactivity across the parasympathetic nervous system (PNS), sympathetic nervous system (SNS), and hypothalamic-pituitary-adrenal (HPA) axis. The first three patterns (i.e., I-III) described in the ACM correspond to the extreme ends and midpoint of the stress reactivity distribution discussed in the theory of biological sensitivity to context (Boyce & Ellis, 2005; Ellis & Boyce, 2008). The first pattern, a sensitive phenotype, develops in a safe, low stress environment and is characterized by high PNS responsivity, high-moderate
SNS responsivity, and high HPA axis reactivity. These levels are hypothesized to increase an individual’s sensitivity to social-emotional and physical input in order to promote sustained learning, social cooperation, and allow them to rapidly adjust to temporary changes (Del Giudice et al., 2011). The second pattern, a buffered phenotype, develops in a moderately stressful environment and is characterized by low-moderate responsivity across the PNS, SNS, and HPA axis. This profile is noted to most closely resemble an ‘optimal’ or protective responsivity profile, as it seeks to strike a balance between the costs and benefits of responsivity and is not theoretically linked to the dysfunctional outcomes associated with hyperresponsivity (i.e., pattern III) and hyporesponsivity (i.e., pattern IV) (Del Giudice, 2014). Buffered phenotypes are predicted to experience lower levels of anxiety, aggression, and risk-taking behaviours, as well as being more open to social feedback (Del Giudice et al., 2011). The third pattern, a vigilant phenotype, develops in an unpredictable, dangerous environment and is characterized by low-moderate PNS responsivity, high SNS responsivity, and high HPA axis reactivity. This profile is hypothesized to allow individuals to cope effectively with threats, which typically predisposes males towards more vigilant-agonistic behaviours (III-A) and females towards more vigilant-withdrawn behaviours (III-W) (Del Giudice et al., 2011). The final pattern, an unemotional phenotype, develops in a severe or traumatic environment and is characterized by low responsivity across the PNS, SNS, and HPA axis. This profile experiences generalized hyporesponsivity, which is theorized to inhibit social-emotional learning, reduce openness to social feedback, and increase risk-taking behaviours (Del Giudice et al., 2011; Del Giudice, 2014). Given that greater exposure to
childhood adversity likely represents early contexts characterized by unpredictability and trauma, the forthcoming hypotheses and associations will be primarily discussed in terms of the vigilant (pattern III) and unemotional (pattern IV) phenotypes. However, this dissertation examines maternal exposure to childhood adversity across a range of early experiences, and thus additional discussion will consider the relevance of the reported results in regards to the sensitive (pattern I) and buffered (pattern II) phenotypes.

1.6.b. Thesis Objectives

Within the context of parental exposure to childhood adversity, the ACM offers insight regarding how life history strategies based on early environmental conditions shape an individual’s reproductive effort and parenting-related processes. The ACM has been conceptually applied to the study of family adversity, and this perspective describes socioemotional functioning as a central tenet of an individual’s life history strategy, with emotional difficulties contributing to the deterioration of adult health and the intergenerational transmission of risk (Cabeza de Baca, Wahl, Barnett, Figueredo, & Ellis, 2016). This conceptual work has received some empirical support, with research demonstrating that emotion regulation problems serve as a pathway linking exposure to childhood adversity to negative health outcomes in adulthood (Poole, Dobson, & Pusch, 2017; Salinas-Miranda et al., 2015).

Therefore, based on the theoretical framework of the ACM, this thesis will examine a conceptual model linking maternal history of childhood adversity to current emotion regulation capacity, in order to explain differences in physiological reactivity,
attentional processing of social-emotional information, and parenting-related processes. I hypothesize that a latent variable of emotion regulation capacity, integrating the Process Model and Multidimensional Emotion Dysregulation Model of emotion regulation, will broadly differentiate between vigilant and unemotional phenotypes in mothers reporting exposure to childhood adversity. Based on the responsivity profiles and resulting behaviours described in the ACM, I hypothesize that mothers exposed to greater childhood adversity with strengthened emotion regulation capacity will display outcomes consistent with the vigilant phenotype (i.e., increased cortisol reactivity, increased attention towards social-emotional information, and child outcomes associated with adaptive parental reactivity to threat). Additionally, I hypothesize that mothers exposed to greater childhood adversity with current difficulties with emotion regulation will display outcomes consistent with the unemotional phenotype (i.e. decreased cortisol reactivity, decreased attention towards social-emotional information, and child outcomes associated with parental social-emotional dysregulation).
Chapter 2: Study 1

General Purpose

The literature examining neuroendocrine responsivity in adults exposed to childhood trauma reports conflicting findings, with some studies reporting blunted cortisol reactivity (Bunea et al., 2017; Carpenter et al., 2011) and others increased cortisol reactivity (Heim et al., 2002). Accordingly, the ACM provides a framework describing the differentiation of HPA axis responsivity following exposure to traumatic early environments that might aid in the interpretation of this variability. In the ACM, the vigilant phenotype is characterized by hyperreactivity of the stress response system, specifically by high basal activity and responsivity of the HPA axis (Del Giudice et al., 2011). Thus, compared to the sensitive phenotype, vigilant individuals are theorized to exhibit slower HPA axis recovery (i.e., take longer to return to baseline HPA activity) and habituation (Del Giudice, 2014). Conversely, the generalized hyporeactivity of unemotional phenotypes is more complex, as individuals with this responsivity profile are likely to display blunted HPA axis reactivity to challenge, but may respond with autonomic activation when confronted with immediate physical and agonistic threats (Del Giudice et al., 2011). Given that adults exposed to childhood adversity are more likely to experience difficulties with emotion regulation (Cloitre et al., 2008; O’Mahen, Karl, Moberly, & Fedock, 2015; Paivio & Laurent, 2001), and emotion dysregulation places individuals at risk for maladaptations to biological stress response systems (Campos, Campos, & Barrett, 1989), the first objective of this thesis is to examine maternal emotion
regulation capacity as a factor that differentiates between HPA axis responsivity profiles in postpartum women reporting greater exposure to childhood trauma.
Title, Authorship, and Copyright

Title: Difficulties with emotion regulation moderate the association between childhood history of maltreatment and cortisol reactivity to psychosocial challenge in postpartum women

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Abstract

Exposure to child maltreatment can lead to long-term emotional difficulties and dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis. However, no prior work has examined emotion regulation as a moderator of the association between childhood history of maltreatment and cortisol response to psychosocial challenge. Amongst a sample of 140 postpartum women, associations between childhood maltreatment, emotion regulation, and cortisol response to a computerized Emotional Stroop paradigm were examined using structural equation modeling. Three saliva samples (baseline, 20- and 40-min post-challenge) were collected and later assayed for cortisol. Stepwise regression analyses revealed that difficulties with emotion regulation significantly moderated the association between maternal history of child maltreatment and cortisol reactivity ($\beta=-0.17$, CI$_{95}$=-0.31, -0.04, t=-2.51, p=0.01). Specifically, women with higher child maltreatment scores and greater difficulties with emotion regulation displayed reduced cortisol reactivity. This finding suggests that diminished emotion regulation capacity may uniquely contribute to blunted physiological reactivity in postpartum women exposed to higher levels of child maltreatment. As the postpartum period has significant implications for maternal well-being and infant development, these findings are discussed in terms of adaptive responsivity, maternal behaviour, and clinical practice.
Introduction

Although the experiences of trauma occur during childhood, the impact of child maltreatment can persist throughout the lifespan (Gilbert et al., 2009). Exposure to child maltreatment can have harmful effects on brain development leading to psychobiological changes (Bremner & Vermetten, 2001; Thompson, Hannan, & Miron, 2014). These changes include alterations to allostatic mechanisms in the neuroendocrine system that are responsible for responding to conditions of acute challenge (Ehring & Quack, 2010; McEwen, 2002a), and neural regions underlying emotional processing and emotion regulation (Goldsmith, Pollak, & Davidson, 2008; Teicher & Samson, 2016).

Neuroendocrine systems, like the hypothalamic-pituitary-adrenal (HPA) axis, that are engaged in responding to challenging and emotional situations are particularly sensitive to early influences and undergo many changes throughout development (Juul et al., 2016; Perlman, Kalish, & Pollak, 2008). The postpartum era poses a period of particular vulnerability for women in terms of mental health and emotional difficulties (Robertson, Grace, Wallington, & Stewart, 2004). However, the long-term impact of child maltreatment on the regulation and physiological response to emotional information in women entering their childrearing years is relatively unexplored. Therefore, the purpose of the current study was to investigate cortisol reactivity and difficulties with emotion regulation in postpartum women with a history of childhood maltreatment. Investigating this relationship is acutely important during the postpartum period, as postpartum women with history of child maltreatment are at an increased risk of experiencing emotional difficulties (Collishaw et al., 2007; Sexton, Hamilton, McGinnis, Rosenblum, & Muzik,
Emotion Regulation and Child Maltreatment

Emotions interact with other goals and behaviours, and thus require dynamic and effortful regulation (Gross et al., 2011). Emotion regulation is defined as the essential processes for monitoring, evaluating, and modifying emotional reactions (Thompson, 2008). One example of an emotion-regulatory act is an emotion regulation strategy, and emotion regulation strategies can be broadly differentiated based on whether they act adaptively on the antecedent of an emotion or maladaptively on the emotional response itself (Gross, 1998). Trait reappraisal is an example of an antecedent-focused strategy, where cognitive effort is used to modify the interpretation of a situation before an emotional response is generated (i.e., attempting to think about a potentially emotional event in non-emotional terms) (Gross, 1998, 2002). An example of a response-focused strategy is trait suppression, where a behavioural attempt is made to reduce an emotional response already underway (i.e., hiding an emotional outburst to a distressing event) (Gross, 2002; Gross & Levenson, 1993). Alternatively, effective emotion regulation can also be defined by global abilities that include understanding emotions, accepting negative emotions, behaving according to desired goals, controlling impulsivity, and using contextually-appropriate strategies (Cole, Michel, & Teti, 2008; Gratz & Roemer, 2004; Thompson et al., 1996). Previous research has demonstrated that both maladaptive emotion regulation strategies (Aldao et al., 2010; Gross, 1998) and global dimensions of
emotion dysregulation (Aldao et al., 2010; Dixon-Gordon et al., 2014) are linked to higher incidences of mood disorders and other social-emotional difficulties.

Children who experience negative parenting environments characterized by maltreatment are at risk of developing social-emotional development issues (Luke & Banerjee, 2013). Specifically, children exposed to chronic stress, abuse, and/or neglect can exhibit difficulties regulating their emotional and behavioural responses to emotional information (Lupien et al., 2009; Pollak, 2008). Children who experience trauma are more frequently aroused, and as a consequence, are often unable to monitor their reactions and regulate their emotions (Dodge et al., 1995; Ford et al., 2009). They have a lower tolerance for negative emotions and may employ more avoidant and response-focused emotion regulation strategies, which can hinder their emotional processing (Luke & Banerjee, 2013; Pollak & Tolley-Schell, 2003). During the period of maltreatment, these emotional responses may represent an adaptation to a stressful environment, but these response patterns can persist and manifest as emotional dysregulation in adulthood (Pollak, 2008; Thompson et al., 2014). Adults with a history of childhood maltreatment have been found to experience difficulties empathizing and regulating their emotional responses (Cloitre et al., 2008; Paivio & Laurent, 2001). Examining the persistent influence of child maltreatment on these abilities across the lifespan will help identify if emotion regulation serves as a potentially modifiable risk factor and target for preventative intervention. This relationship is critical to examine in new mothers as women are particularly vulnerable to emotional dysfunction during the postpartum period (Robertson et al., 2004), and maternal emotion regulation capacity greatly influences
parenting behaviour and infant development (Haga et al., 2012; Neumann, Krömer, & Bosch, 2005).

**Cortisol Response to Challenge and Childhood Maltreatment**

Sustained exposure to stress and negative environments also has implications for the hypothalamic-pituitary-adrenal (HPA) axis (Tarullo & Gunnar, 2006). Exposure to child maltreatment has been linked to an altered, and often maladaptive, cortisol response in both children and adults (Charmandari, Kino, Souvatzoglou, & Chrousos, 2003; Ehlert, 2013). However, across studies there is debate on the magnitude and direction of this relationship. Some studies have reported that child maltreatment is associated with increased cortisol reactivity (Cicchetti & Rogosch, 2001; Harkness, Stewart, & Wynne-Edwards, 2011; Linares, Shroui, Nucci-Sack, & Diaz, 2013), whereas others have shown that maltreated adolescents and adults exhibit decreased, or blunted cortisol response (Carpenter et al., 2007; MacMillan et al., 2009; Ouellet-Morin et al., 2011).

The direction of cortisol reactivity reported in maltreatment research can vary based on the age of the sample, concurrent psychiatric diagnosis, and whether the methodological design utilizes a psychosocial challenging task or exogenous administration of hormones to stimulate the HPA axis (Abravanel & Sinha, 2015). One method that helps disentangle the complex relationships between variables is through the identification and testing of potential moderating variables. For example, some studies have shown that chronicity, maltreatment type, and presence of internalizing or externalizing problems influence the direction of cortisol reactivity (Cicchetti & Rogosch,
2001; Cicchetti, Rogosch, Gunnar, & Toth, 2010; Heim, Newport, et al., 2000; McCrory, De Brito, & Viding, 2011). In addition, there is research to suggest that emotion regulation is a mechanism through which exposure to child maltreatment is related to maladaptive psychological and emotional outcomes (Langevin, Hébert, & Cossette, 2015; Maughan & Cicchetti, 2002). However, emotion regulation has not yet been explored as a potential moderator in the association between child maltreatment and adult physiological responsivity to challenge. As a recent study reported that postpartum women exposed to adversity during childhood are at increased risk for disrupted affect and cortisol dysregulation (Juul et al., 2016), examination of this relationship in new mothers is a crucial extension.

**Emotion Regulation and Physiological Reactivity to Challenge**

Regulating emotions requires general attentional and cognitive resources that activate physiological systems in challenging situations (Aldao, 2013; Butler, Wilhelm, & Gross, 2006). Difficulties with emotion regulation place an individual at risk for maladaptations to other systems responsible for responding to acute challenge (Campos et al., 1989). Although emotion regulation is noted to encompass a broad range of processes, empirical investigation focuses on connecting specific emotion regulation strategies, like trait suppression and reappraisal, to patterns of physiological reactivity (Gross, 2002; Gross & Levenson, 1993). Studies show that employing maladaptive emotion regulation strategies, such as trait suppression, increase cardiovascular and electrodermal activation (Egloff, Schmukle, Burns, & Schwerdtfeger, 2006; Gross, 1998).
Additional research has shown that use of adaptive emotion regulation strategies, like trait reappraisal, is associated with a reduction in cardiovascular and autonomic reactivity (Butler et al., 2006; Gross & John, 2003; John & Gross, 2004).

Research linking emotion regulation to cortisol reactivity has reported somewhat conflicting results, with some studies indicating that higher levels of both adaptive (de Veld, Riksen-Walraven, & de Weerth, 2012; Denson, Creswell, Terides, & Blundell, 2014; Gaab et al., 2003; Lam, Dickerson, Zoccola, & Zaldivar, 2009) and maladaptive emotion regulation strategies (de Veld et al., 2012; Lam et al., 2009; Zoccola, Dickerson, & Zaldivar, 2008) are associated with increased cortisol reactivity in response to stress, psychosocial challenge, pain, and social-evaluation. Conversely, greater use of trait reappraisal has been associated with decreased cortisol reactivity to psychosocial challenge (Carlson, Dikecligil, Greenberg, & Mujica-Parodi, 2012). Finally, emotional non-acceptance (i.e., a tendency to have secondary emotional responses like shame or guilt to negative emotions) was negatively associated with cortisol reactivity to social threat in adults exposed to early life stress (Cărnuță, Crișan, Vulturar, Opre, & Miu, 2015).

Using more integrative models of emotion regulation in scientific research is an important step to better understanding its relation to health and physiological vulnerability (Dixon-Gordon et al., 2014). Prior work has advised that the strategy-focused model of emotion regulation is too simplistic, as specific emotion regulation strategies are often context-dependent and adaptive emotion regulation requires flexibility and more global skills (Aldao & Dixon-Gordon, 2014; Cole et al., 2004). Given that new motherhood elicits a broad range of both positive and negative emotions, a woman’s
emotion regulation capacity can greatly influence her postpartum well-being and ability to respond to stressful and challenging conditions (Haga et al., 2012; Neumann et al., 2005). Therefore, in order to potentially resolve the conflict within the existing literature, in the current study we sought to evaluate a repertoire of emotion regulation abilities as a potential moderator of the relationship between child maltreatment and cortisol secretion to psychosocial challenge.

**Extending Previous Research**

In order to inform our research hypotheses on the long-term sequelae of child maltreatment on maternal cortisol responsivity, we have turned to the Adaptive Calibration Model (ACM; Del Giudice, Ellis, & Shirtcliff, 2011). The ACM is an evolutionary model of the development of stress reactivity that extends from biological sensitivity to context theory (Boyce & Ellis, 2005), and is complementary to differential susceptibility theory (Ellis, Boyce, Belsky, Bakermans-Kranenburg, & van Ijzendoorn, 2011). ACM postulates that physiological responsivity results largely from conditional adaption, the evolved capacity of an individual to modify their developmental trajectory corresponding to environmental conditions (Del Giudice et al., 2011). Developing in a stressful context as a child can lead to diverse patterns of responsivity in adulthood. These responsivity profiles range from vigilant phenotypes that display increased physiological reactivity and attention to threat, to unemotional phenotypes that exhibit decreased reactivity and blocking of threat-related information (Del Giudice et al., 2011). We hypothesize that emotion regulation is a factor that will modulate between these two
responsivity profiles in new mothers with childhood history of maltreatment. As it is unethical to ask postpartum women to complete a task that is demanding or stressful beyond what they might experience on a daily basis, considerations were made to select the most appropriate challenging task. An Emotional Stroop task was selected as previous research has shown that the this task influences salivary cortisol response patterns (van Honk et al., 2000). Additionally, the Emotional Stroop paradigm used in the present study included attachment-related stimuli, as for survivors of maltreatment these stimuli may more greatly signal threat (Pollak, Cicchetti, & Klorman, 1998; Williams et al., 1996), and response latencies towards these stimuli are related to mother-infant attachment during the postnatal era (Atkinson et al., 2009).

During the postpartum period there are several factors which increase the risk of emotional disturbance, including: lower socioeconomic status, difficulties breastfeeding, sleep disturbances, and history of childhood maltreatment (Collishaw et al., 2007; Grekin & O’Hara, 2014; Haga et al., 2012; O’Hara & Swain, 1996; Sexton et al., 2015). These factors will be considered as covariates in our analytical models. In addition to the reported links between childhood history of maltreatment and cortisol reactivity, there is evidence to suggest there exists an association between baseline cortisol concentrations and childhood maltreatment (Carpenter et al., 2007; Sumner, McLaughlin, Walsh, Sheridan, & Koenen, 2014; Tyrka et al., 2009). Therefore, preliminary analysis will explore whether baseline cortisol levels are predicted by childhood history of maltreatment. The main analyses will then investigate whether latent difficulties with emotion regulation moderates the association between childhood history of maltreatment
and cortisol response to an Emotional Stroop task in a sample of postpartum women. This study is based on the premise that mothers with experiences of early trauma may experience a greater challenge at regulating their emotional states and we theorize that this will modulate their cortisol responsivity. We hypothesize that emotion regulation ability will modulate physiological reactivity, differentiating between the two responsivity profiles proposed in the ACM that develop following exposure to highly stressful environments. We hypothesize that women reporting strengthened emotion regulation capacity will display a vigilant phenotype characterized by increased reactivity, and that women reporting greater difficulties with emotion regulation will display an unemotional phenotype characterized by decreased reactivity. Examining these relationships in a postpartum sample may help pinpoint a target for preventative intervention, and has implications for parenting, child development, and clinical practice.

Materials & Methods

Sample & Procedure

Participants included a community sample of 140 new mothers who were recruited from the maternity ward at St. Joseph’s Healthcare Hamilton, Ontario. Women were approached in the maternity ward by a trained research assistant, and interested women gave their consent to be contacted. At around 9-10 weeks postpartum, women were contacted by phone using a standardized recruitment protocol, in order to request for their consent to participate in the study. Women who consented to participate were
visited in their homes by two research staff, and at the time of each home visit informed, written consent was obtained from all participants. The McMaster Research Ethics Board and the Research Ethics Board of St. Joseph’s Healthcare Hamilton approved the study protocol.

Inclusion criteria for mothers were as follows: a) be age 18 years or older at the time of birth; b) have given birth to a full-term healthy infant; c) be able to access their infants at the time of the home visits; and d) have the ability to read, write, and speak English. Exclusion criteria comprised any characteristics that would not permit participants to complete the research measures. This included cases of severe mental illness (e.g., psychosis), physical disability, and language barriers (e.g., inability to read, write, understand, or speak English). In the current sample, 12.9% of women reported belonging to a visible minority. At the time of the 7-month postpartum visit, women in the sample ranged from 22 to 41 years of age (M = 32.3, SD = 4.4), 67.1% were breastfeeding, and 65.7% weren’t currently on any prescription medications (9.3% were on anti-depressants, 8.6% oral contraceptives, 6.4% thyroid medication, 3.6% lactation aids). Most participants were either married or living common law (92.9%) and university educated (67.9%). The median family income was between $92,000 - $113,999 Canadian dollars.

Data were collected from May 2013 until December 2014 by a research team at the Offord Centre for Child Studies. Mothers and their infants were seen during two home visits. Women who consented to participate completed two 2-hour home visits at 3-months postpartum and again at 7-months postpartum. All home visits were completed.
between 1000h and 1600h, and visits were scheduled at the mother’s convenience so as to accommodate the infant’s feeding and sleeping schedule. During the 3-month home visit, demographic data were gathered and mothers were asked about their exposure to child maltreatment. During the 7-month home visit, information from mothers was collected about their daily habits, emotion regulation, cortisol responsivity, and mood.

Measures

**Demographic Information & Daily Habits.** During the 3-month home visit, mothers completed a background information questionnaire that collected data about their marital status (single, married, common law, separated/divorced), education level (ranged from less than high school to postgraduate studies) and household income (ranged from less than $20,000 to $150,000+). During the 7-month home visit, mothers completed questionnaires about breastfeeding (yes or no), medication use (anti-depressants, thyroid medication, oral contraceptives, lactation aids, etc.), and sleep patterns (bedtime, wake time).

**Maternal History of Childhood Maltreatment.** To assess experiences of childhood maltreatment participants completed the Childhood Trauma Questionnaire (CTQ; Bernstein & Fink, 1998) at their 3-month postpartum visit. The CTQ is a 28-item self-report questionnaire that evaluates types and frequency of abuse and neglect using a 5-point Likert scale (1 = never; 5 = very often). In the present sample using moderate-
severe cutoffs, 15.7% of women reported experiencing emotional abuse, 12.9% reported sexual abuse, 7.9% reported physical abuse, 4.3% reported physical neglect, and 0.7% reported emotional neglect. Overall, 22.1% of women reported experiencing at least one form of moderate-severe childhood trauma and 11.4% of women reported experiencing two or more forms of moderate-severe childhood trauma. The CTQ also provides a total score, which cumulatively considers the different forms of maltreatment. The CTQ total score was used as a continuous variable for the purpose of statistical analyses (M = 28.0, SD = 12.3). The CTQ has demonstrated strong reliability and validity over time, and in relation to other retrospective maltreatment assessment tools (Paivio & Cramer, 2004; Scher, Stein, Asmundson, McCreary, & Forde, 2001). In the present sample, the CTQ total score had good internal consistency (Cronbach’s α = 0.80).

**Emotion Regulation Questionnaires.** During the 7-month postpartum visit, participants completed the Emotion Regulation Questionnaire (ERQ; Gross & John, 2003). The ERQ is a 10-item self-report questionnaire that assesses the levels of two chief emotion regulation strategies, expressive suppression and cognitive reappraisal. Suppression includes items such as, “When I am feeling negative emotions, I make sure not to express them.” Reappraisal includes items such as, “When I’m faced with a stressful situation, I make myself think about it in a way that helps me stay calm.” Participants answered items on a seven-point Likert scale (1 = strongly disagree; 7 = strongly agree) and items were grouped together into composite variables for each trait.
strategy. In the present sample, the ERQ has acceptable internal consistency for both trait reappraisal (Cronbach’s $\alpha = 0.84$) and suppression (Cronbach’s $\alpha = 0.72$).

At the 7-month postpartum visit, participants’ global emotion regulation difficulties were assessed using the Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004). The DERS is a 36-item self-report questionnaire that assesses both an individual’s general difficulties regulating their emotions and their specific difficulties across six dimensions. These dimensions include: non-acceptance of negative emotions, difficulties engaging in goal-directed behaviours when distressed, difficulties controlling impulsive behaviours when experiencing negative emotions, limited access to emotion regulation strategies perceived as effective, lack of emotional awareness, and lack of emotional clarity. Participants rated items on a five-point Likert scale ($1 = almost never; 5 = almost always$). Total scores from each of the six dimensions of difficulties with emotion regulation were determined. The DERS has been found to have high overall internal consistency and adequate internal consistency within each subscale (Gratz & Roemer, 2004; Neumann, van Lier, Frijns, Meeus, & Koot, 2011). In the present sample, the questionnaire had high internal consistency overall (Cronbach’s $\alpha = 0.83$) and acceptable internal consistency within each subscale ($0.70 \geq$ Cronbach’s $\alpha \leq 0.86$).

**Measuring Difficulties with Emotion Regulation.** To address previous concerns regarding the importance of studying emotion regulation more comprehensively, the current study investigated emotion regulation as a latent variable composed of subscale scores from both the ERQ and DERS. The DERS subscale scores are commonly
accepted as indicators of emotion dysregulation, where higher scores indicate greater
difficulties with emotion regulation (Gratz & Roemer, 2004). Conversely, the two trait
strategies scores derived from the ERQ are viewed as separate and differentially
advantageous. Traditionally, trait suppression is considered maladaptive and trait
reappraisal is considered adaptive (Gross & Levenson, 1997; Mauss, Bunge, & Gross,
2007). Higher scores on the trait suppression subscale are considered to indicate
ineffective emotion regulation, and recent research has used the reverse-scored subscale
of trait reappraisal from the ERQ to indicate difficulties in emotion regulation (Scott et
al., 2013).

The latent variable of difficulties with emotion regulation collectively considered
the six subscale scores from the DERS, the suppression subscale score from the ERQ, and
the reverse-scored reappraisal scale from the ERQ (see Figure 1). Bivariate correlations
amongst emotion regulation variables in the measurement model of the difficulties with
emotion regulation construct were assessed. There were numerous significant Pearson
correlations between the different measures of emotion regulation (|0.19| ≥ r ≤ |0.54|, p <
0.05), which were accounted for in the measurement model. This is consistent with
previous studies that have incorporated subscales from the ERQ and the DERS, which
found small-moderate correlations between subscales (|0.16| ≥ r ≤ |0.50|, p < 0.05)
(Bardeen & Fergus, 2014; Ehring & Quack, 2010; Zelkowitz & Cole, 2016).
Figure 1. Measurement model and results for the latent variable difficulties with emotion regulation.

*Note.* The circle represents the latent variable and the rectangles represent the observed variables. Standardized beta coefficients are reported; *p < 0.01.

Non-Acceptance_DERS = non-acceptance of negative emotions from the DERS-II; Goal-Directed_DERS = difficulties engaging in goal-directed behaviour from the DERS-II; Impulsive_DERS = difficulties controlling impulsive behaviours from the DERS-II; Strategies_DERS = limited effective emotion regulation strategies from the DERS-II; Awareness_DERS = lack of emotional awareness from the DERS-II; Clarity_DERS = lack of emotional clarity from the DERS-II; Reappraisal = reverse-scored trait reappraisal from the ERQ; and Suppression_ERQ = trait suppression from the ERQ.
**Postpartum Mood.** To assess postpartum depression participants completed the Edinburgh Postnatal Depression Scale (EPDS; Cox, Holdenand, & Sagovsky, 1987) at the 7-month visit. The EPDS is a 10-item screening tool used to assess depressive and anxious symptomology in postpartum populations. Cutoff scores are often used to categorize women who are at risk for developing postpartum depression (scores of 9-10), or who display moderate to severe levels of postpartum depression symptomology (scores of 11-15+), but there is considerable variation in cutoffs used across studies (Eberhard-Gran, Tambs, Opjordsmoen, Skrondal, & Eskild, 2003). In the present sample, 18.6% of women had an EPDS score (≥ 9). For the purpose of this study, EPDS score was used as a continuous covariate in the moderation analyses (M = 5.9, SD = 4.2). The EPDS has been found to have high sensitivity, specificity, and reliability in past research (Matijasevich et al., 2014; Zhong et al., 2014). In the present sample, EPDS items had high internal consistency (Cronbach’s α = 0.84).

**Psychosocial Challenge: Emotional Stroop Computerized Task.** At the 7-month visit, participants completed a 17-minute computerized Emotional Stroop task involving emotional and neutral stimuli. The Emotional Stroop paradigm is a clinically-relevant adaptation of the original Stroop procedure, where the emotional significance of word stimuli is varied so as to study the interference of emotionally salient words on colour naming (Williams et al., 1996). The Emotional Stroop has been previously used to investigate the relationship between selective attention to cues of social and emotional threat and engagement of the HPA axis (Hänsel & Von Känel, 2013; Roelofs, Bakvis,
Hermans, van Pelt, & van Honk, 2007). Previous work has shown that both the traditional Stroop (Dickerson & Kemeny, 2004; Skoluda et al., 2015) and Emotional Stroop (van Honk et al., 2000) stimulate intra-individual variability in HPA axis response and influence salivary cortisol levels. Additionally, recent research has suggested that the Emotional Stroop task acts as a mood induction task and engages emotion regulation mechanisms (Ben-Haim, Mama, Icht, & Algom, 2014; Kappes & Bermeitinger, 2016). Therefore, the Emotional Stroop task provides an appropriate metric for the current exploration of the influence of emotion regulation capacity on cortisol response to psychosocial challenge.

The Emotional Stroop paradigm used in the present study included neutral words (e.g., ‘pattern’, ‘atmosphere’), negative emotional words (e.g., ‘disease’, ‘danger’), and attachment-related negative emotional words (e.g., ‘abandon’, ‘neglect’). The task required participants to correctly indicate the font colour of presented word stimuli by pressing keyboard buttons. Before beginning the full test, participants completed a 90-second practice test with only neutral stimuli in order to become comfortable with the instructions. The full test lasted 15-minutes and involved 240 stimuli presentations. Stimuli were counterbalanced across test trials. Using the standard procedure, attention bias scores were computed by subtracting the average reaction time of the neutral word category from the average reaction time of the negative emotional word category (McHugh, Behar, Gutner, Geem, & Otto, 2010; Williams et al., 1996). The average response latency for the neutral word category (M = 832.51, SD = 139.08), the negative emotional word category (M = 832.95, SD = 138.50), and the attachment-related word
category (M = 833.25, SD = 129.43) were similar. As previous research has shown that attention bias scores from the Emotional Stroop task are associated with neuroendocrine activity (van Honk et al., 2000), attention bias scores for both negative emotional stimuli (M = 0.44, SD = 28.50) and attachment-related stimuli (M = 3.01, SD = 31.88) were explored as predictor variables in the moderation model.

**Salivary Sample Collection.** For 60 minutes prior to the start of the 7-month home visit, participants were required to refrain from brushing their teeth, eating, and drinking in order to avoid contamination of the salivary samples (Hellhammer, Wüst, & Kudielka, 2009; Kirschbaum & Hellhammer, 1994). All visits commenced between 1000h and 1430h (M = 1138h, SD = 0135.7h), and immediately following consent procedures the first salivary sample was collected. The start time of salivary sample collection start time was included in analyses as a covariate. Immediately following the baseline sample collection, participants completed the computerized Emotional Stroop task. Then two more samples were collected at 20- and 40- minutes following completion of the task. Saliva was collected via passive drool using a salivary collection aid device (Salimetrics, State College, PA) and a microvial. Participants were instructed to accumulate saliva in their mouth for 1 minute before passive drool collection. The number of attempts and time period it took a participant to give 1.0ml of saliva at each sample time were noted on a collection form. Within a few hours of the visit, samples were stored below -20°C, and later put into long-term storage at -70°C. For assay, microvials were thawed and centrifuged for 10 minutes at 3000 rpm at 4-8°C. Samples
were assayed using a high sensitivity enzyme immunoassay kit (Salimetrics, State College, PA). All samples were assayed in duplicate and average values were used in the analyses. The inter-assay variability was 10.2%. For samples with low values the intra-assay variation was 7.8%, and for samples with high values the intra-assay variation was 6.9%.

**Area Under the Curve Calculation.** Using methods developed by Pruessner and colleagues (2003) area under the curve (AUC) computation was completed in order to look at fluctuations in cortisol secretion. AUC computation is often used in endocrinological research as it gives an estimate of ultradian changes in hormonal secretion (Pruessner, Hellhammer, & Kirschbaum, 1999; Pruessner, Kirschbaum, Meinlschmid, & Hellhammer, 2003). The index of cortisol secretion calculated was AUC with respect to increase (AUC\textsubscript{I}). AUC\textsubscript{I} is contingent on the number of measurements and emphasizes changes over time, giving a time-dependent measure of hormonal reactivity. Only AUC\textsubscript{I} was considered in the present study, as it is more commonly utilized as a biomarker of hormonal reactivity in research on individual variability to challenging conditions (Hellhammer et al., 2009; Khoury et al., 2015).

**Statistical Approach & Preliminary Analyses**

**Missing Data & Transformations.** Among the 140 participants in this sample, 14.3% (n = 20) were missing one or more cortisol samples (11.7% were missing only one
sample and 2.5% were missing two or more samples). This was due to the inability of some women to produce sufficient saliva on one or more occasions. Otherwise, 96.4% (n = 135) had complete data on the other variables of interest (e.g., socioeconomic status, postpartum mood, history of childhood maltreatment, emotion regulation subscale scores, Emotional Stroop response latency data, etc.). Based on Little’s Missing Completely at Random (MCAR) test, $x^2 (185) = 143.25, p > 0.05$, these data were deemed appropriate for imputation. Missing data were imputed for all variables using imputation techniques in SPSS 22.0 (IBM Corp., 2013). Following recommended procedures, expectation maximization methods were used to impute 100 data files and then one imputed dataset was randomly selected for descriptive statistics, preliminary analysis, and structural equation modeling (Bodner, 2008; Rashbash, Steele, Browne, & Goldstein, 2015).

Prior to any analyses, skewed cortisol data were transformed. This included the sample data (baseline, 20-minutes post challenge, and 40-minutes post challenge) and the outcome variable (AUC$_t$). In order to correct for non-normality, the cortisol values were initially winsorized, a process that involves modifying extreme values in order to limit the impact of potentially spurious outliers (Ghosh & Vogt, 2012). Following this modification, the outcome variable (AUC$_t$) for the structural equation model was normally distributed (M = 2.19, SD = 36.64). Even after winsorization the cortisol data were still skewed, so a base-10 logarithmic transformation was applied. Following this transformation, the baseline sample data were still skewed; however, the data for the other two samples (20-minutes and 40-minutes post challenge) were normally distributed. Therefore, preliminary analyses used nonparametric tests to investigate the associations.
between the variables of interest and the winsorized cortisol sample data (baseline sample M = 4.70 nmol/L, SD = 3.17; 20-minutes post challenge sample M = 4.84 nmol/L, SD = 2.74; 40-minutes post challenge sample M = 4.17 nmol/L, SD = 2.10). Spearman’s rank order correlations are reported in Table 1.

Table 1

Spearman correlations amongst cortisol sample data and study variables.

<table>
<thead>
<tr>
<th></th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Medication</td>
<td>-.13</td>
<td>-.09</td>
<td>-.07</td>
</tr>
<tr>
<td>2. Breastfeeding Status</td>
<td>.11</td>
<td>.03</td>
<td>.02</td>
</tr>
<tr>
<td>3. Sample Collection Time</td>
<td>-.20*</td>
<td>-.14</td>
<td>-.20*</td>
</tr>
<tr>
<td>4. Wake Time</td>
<td>.17*</td>
<td>.14</td>
<td>.06</td>
</tr>
<tr>
<td>5. Bed Time</td>
<td>.15</td>
<td>.20*</td>
<td>.18*</td>
</tr>
<tr>
<td>6. Marital Status</td>
<td>.09</td>
<td>.06</td>
<td>-.01</td>
</tr>
<tr>
<td>7. Education</td>
<td>.06</td>
<td>.02</td>
<td>.06</td>
</tr>
<tr>
<td>8. Household Income</td>
<td>-.11</td>
<td>-.06</td>
<td>-.03</td>
</tr>
<tr>
<td>9. Minority Status</td>
<td>-.10</td>
<td>.02</td>
<td>.11</td>
</tr>
<tr>
<td>10. EPDS Score</td>
<td>.19*</td>
<td>.20*</td>
<td>.18*</td>
</tr>
<tr>
<td>11. CTQ Score</td>
<td>.17*</td>
<td>.18*</td>
<td>.07</td>
</tr>
<tr>
<td>12. Attention Bias Score</td>
<td>-.16</td>
<td>-.24*</td>
<td>-.24*</td>
</tr>
</tbody>
</table>

* p < 0.05 level.

Sample 1 = baseline cortisol level; Sample 2 = 20-minutes post-challenge cortisol level; and Sample 3 = 40-minutes post-challenge cortisol level.
Structural Equation Model (SEM). The main analytical approach was to determine whether and how latent difficulties with emotion regulation would interact with maternal exposure to childhood maltreatment to predict cortisol reactivity. These main analyses were completed using SEM in Mplus 7 (Muthén & Muthén, 1998-2012). A latent variable approach was selected because it has an improved ability to assess complex interactions and is statistically efficient, as it reduces parameter estimation (Klein & Moosbrugger, 2000; Maslowsky, Jager, & Hemken, 2015). The measurement model was evaluated using the recommended indices of model fit: the Chi-square test ($\chi^2$), Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), and Tucker Lewis Index (TLI). Following the standard recommendations, in order for a model to be accepted as consistent with the data, the $\chi^2$ test should be non-significant, the RMSEA value should be below 0.06, and the CFI and TLI values should be above 0.95 (Hu & Bentler, 1998; Kline, 2011).

Using SEM, a nested modeling structure was used to explore the additive explanatory influence of predictors on the dependent variable, cortisol reactivity ($AUC_1$). Stepwise regression analyses were used to assess the integrated models considering associations between childhood maltreatment, difficulties with emotion regulation, and cortisol response to challenge. This approach was selected in order to account for possible multicollinearity between predictor variables and to aid in model development, in which non-significant predictors are removed from subsequent models in order to increase model parsimony (Cohen & Cohen, 1983; Cohen et al., 2003; de Jong, 1999). Predictors were entered in a stepwise fashion in the following progression: covariates
were entered on step 1, childhood maltreatment score and the latent difficulties with emotion regulation variable were entered on step 2, and the interaction term (between childhood maltreatment and the latent difficulties with emotion regulation variable) was entered on step 3. Covariates were selected based on a review of the background literature (Collishaw et al., 2007; Grekin & O’Hara, 2014; Haga et al., 2012; O’Hara & Swain, 1996; Sexton et al., 2015). Covariates included sociodemographic factors (marital status, educational attainment, household income, visible minority status), evening bed time, morning wake time, time of day of sample collection, maternal mood, breastfeeding status, medication use, and attention bias scores. The regression analyses utilized an integration algorithm in Mplus, as this uses a maximum likelihood estimator that allows for robust standard errors (Muthén & Muthén, 1998-2012).

Results

Descriptive Statistics and Bivariate Correlations

Detailed descriptives pertaining to sociodemographic information and study variables for the sample (N = 140) are reported in Tables 2 and 3. Bivariate correlations amongst study variables are reported in Table 4. Participant daily habits, postpartum mood, and the majority of the demographic variables were not significantly correlated with cortisol AUC₁.
Table 2

Sociodemographic characteristics.

<table>
<thead>
<tr>
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<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Visible Minority</strong></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>12.9</td>
</tr>
<tr>
<td><strong>Marital Status</strong></td>
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</tr>
<tr>
<td>Single</td>
<td>5.7</td>
</tr>
<tr>
<td>Married</td>
<td>72.9</td>
</tr>
<tr>
<td>Living Common Law</td>
<td>20.0</td>
</tr>
<tr>
<td>Separated or Divorced</td>
<td>1.4</td>
</tr>
<tr>
<td><strong>Education</strong></td>
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<tr>
<td>At least secondary school (Gr. 9-13)</td>
<td>10.0</td>
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<tr>
<td>College</td>
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<tr>
<td>University</td>
<td>40.0</td>
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<tr>
<td>Postgraduate</td>
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</tr>
<tr>
<td><strong>Household Income</strong></td>
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<td>&lt; $20,000</td>
<td>2.9</td>
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<td>$20,000 - 34,999</td>
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<td>$35,000 - 69,999</td>
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<td>$70,000 - 91,999</td>
<td>21.5</td>
</tr>
<tr>
<td>$92,000 - 113,999</td>
<td>30.7</td>
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<td>$114,000 - 149,000</td>
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<td>$150,000+</td>
<td>17.8</td>
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Table 3

Descriptive statistics for study variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (SD)</th>
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<tbody>
<tr>
<td>CTQ Total Score</td>
<td>27.99 (12.34)</td>
</tr>
<tr>
<td>EPDS Total Score</td>
<td>5.91 (4.20)</td>
</tr>
<tr>
<td>Cognitive Reappraisal Reversed Score</td>
<td>18.84 (6.70)</td>
</tr>
<tr>
<td>Expressive Suppression Score</td>
<td>10.77 (4.69)</td>
</tr>
<tr>
<td>Non-acceptance of Negative Emotions</td>
<td>16.10 (2.44)</td>
</tr>
<tr>
<td>Difficulties with Goal-Directed Behaviours</td>
<td>14.51 (1.70)</td>
</tr>
<tr>
<td>Impulsive Behaviours</td>
<td>11.87 (2.66)</td>
</tr>
<tr>
<td>Lack of Emotional Awareness</td>
<td>20.96 (2.90)</td>
</tr>
<tr>
<td>Limited Effective Emotion Regulation Strategies</td>
<td>19.03 (3.43)</td>
</tr>
<tr>
<td>Lack of Emotional Clarity</td>
<td>11.11 (1.74)</td>
</tr>
<tr>
<td>Cortisol Reactivity (AUC1)</td>
<td>-2.19 (36.64)</td>
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</tbody>
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Table 4
Pearson correlations amongst study variables.

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<tr>
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<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
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<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2.</td>
<td>Medication</td>
<td>.18*</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>3.</td>
<td>Breastfeeding Status</td>
<td>-.03</td>
<td>-.16</td>
<td></td>
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<td></td>
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<tr>
<td>4.</td>
<td>Sample Collection Time</td>
<td>-.03</td>
<td>.00</td>
<td>-.02</td>
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<td></td>
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<tr>
<td>5.</td>
<td>Wake Time</td>
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<td>.10</td>
<td>.01</td>
<td>.00</td>
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<tr>
<td>6.</td>
<td>Bed Time</td>
<td>-.11</td>
<td>.06</td>
<td>-.01</td>
<td>-.09</td>
<td>.08</td>
<td>-.42*</td>
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<td>7.</td>
<td>Marital Status</td>
<td>.07</td>
<td>-.13</td>
<td>.07</td>
<td>.08</td>
<td>-.42*</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>8.</td>
<td>Education</td>
<td>.04</td>
<td>.25*</td>
<td>-.06</td>
<td>.01</td>
<td>.16</td>
<td>-.26*</td>
<td></td>
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<tr>
<td>9.</td>
<td>Household Income</td>
<td>.01</td>
<td>.06</td>
<td>-.01</td>
<td>-.09</td>
<td>.33*</td>
<td>-.40*</td>
<td>.28*</td>
<td></td>
<td></td>
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<tr>
<td>10.</td>
<td>Visible Minority Status</td>
<td>-.10</td>
<td>-.16</td>
<td>.03</td>
<td>.01</td>
<td>-.12</td>
<td>.14</td>
<td>-.14</td>
<td>-.05</td>
<td></td>
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<tr>
<td>11.</td>
<td>EPDS Score</td>
<td>.07</td>
<td>-.07</td>
<td>.05</td>
<td>-.20*</td>
<td>-.13</td>
<td>.21*</td>
<td>.00</td>
<td>-.13</td>
<td>.05</td>
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<td></td>
</tr>
<tr>
<td>12.</td>
<td>CTQ Score</td>
<td>.16</td>
<td>.00</td>
<td>-.06</td>
<td>-.10</td>
<td>-.08</td>
<td>.20*</td>
<td>-.14</td>
<td>-.08</td>
<td>.00</td>
<td>.33*</td>
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<td>13.</td>
<td>Attention Bias Score</td>
<td>-.04</td>
<td>.09</td>
<td>.01</td>
<td>.12</td>
<td>-.02</td>
<td>.03</td>
<td>-.06</td>
<td>-.11</td>
<td>.03</td>
<td>-.11</td>
<td>.03</td>
</tr>
<tr>
<td>14.</td>
<td>Cortisol Reactivity (AUCI)</td>
<td>-.08</td>
<td>-.04</td>
<td>-.04</td>
<td>-.05</td>
<td>-.09</td>
<td>-.17*</td>
<td>.00</td>
<td>-.07</td>
<td>.18*</td>
<td>-.04</td>
<td>-.06</td>
</tr>
</tbody>
</table>

* p < 0.05 level.

Salivary Cortisol Response to the Emotional Stroop Task

To explore the impact of the computerized Emotional Stroop task on salivary cortisol concentration differences, paired-samples Sign tests were completed to determine the median difference between related cortisol samples. Between the second and third sample there was a statistically significant decrease in cortisol level (Z = -6.17, p < 0.001). However, between the baseline and second sample there wasn’t a significant direction of difference between levels (Z = -1.62, p = 0.11), as 59 individuals showed a...
decrease in cortisol level and 79 individuals showed an increase in cortisol level (with 2 individuals showing similar levels between samples). Further analyses were conducted to investigate if the interaction between childhood history of maltreatment and emotion regulation capacity influenced the direction of individual responsivity to the task.

**Baseline Salivary Cortisol Level and Childhood History of Maltreatment**

Preliminary data analysis included exploring whether baseline cortisol levels were predicted by childhood history of maltreatment. In order to correct for non-normality, a reciprocal transformation was applied to the skewed baseline cortisol data. A linear regression model was constructed to examine the influence of predictor variables (socioeconomic variables, sleeping habits, medication use, maternal mood, breastfeeding status, and childhood history of maltreatment) on baseline cortisol concentration. Regression analysis revealed that maternal wake time ($b = -0.000019$, $t = -0.20$, $p = 0.02$), medication use ($b = 0.01$, $t = 0.17$, $p = 0.04$), postpartum mood ($b = -0.01$, $t = -0.21$, $p = 0.01$), and history of childhood maltreatment ($b = -0.22$, $t = -2.60$, $p = 0.01$) all significantly predicted baseline cortisol level.

### 3.4 Measurement Model of Latent Difficulties with Emotion Regulation

The first-order measurement model of the difficulties with emotion regulation latent variable included 8 factors: the 6 subscale scores from the DERS, the trait suppression subscale score from the ERQ, and the reverse-scored trait reappraisal subscale score from the ERQ. In the measurement model all factors had standardized
beta coefficients with values $\geq 0.15$ and most were $\geq 0.53$ (see Figure 1). As all of the factors significantly loaded onto the latent construct ($p < 0.001$), all of the subscales were retained in the final measurement model (Kline, 2011). The measurement model of the latent construct of emotion regulation difficulties showed good model fit: $x^2 = 41.18$, df = 35, $p > 0.05$; RMSEA = 0.04; CFI = 0.98; TLI = 0.97.

**Structural Equation Models: Moderation Analyses**

The moderation model examined whether maternal exposure to child maltreatment, latent emotion regulation, and their interaction predicted cortisol response following the Emotional Stroop task. To test for significant covariates, maternal characteristics were entered into the initial regression models. These initial models included sociodemographic variables, sample collection time, bedtime, wake time, EPDS score, medication use, breastfeeding status, sample collection time, and attention bias scores as covariates. Next, maternal history of childhood maltreatment and latent difficulties with emotion regulation were added to the model. Of all of the entered predictor variables, only maternal history of maltreatment ($\beta = -0.18$, $t = -2.13$, $p = 0.03$), bedtime ($\beta = 0.16$, $t = 1.98$, $p = 0.048$), and ethnicity ($\beta = 0.21$, $t = 2.71$, $p = 0.01$) significantly contributed to the variance in cortisol reactivity. Maternal medication use approached significance ($\beta = 0.15$, $t = 1.82$, $p = 0.07$) as a predictor of cortisol reactivity, and was kept in subsequent models. The other non-significant covariates (marital status, education, income level, sample collection time, wake time, EPDS score, breastfeeding status, attention bias scores) were dropped from the subsequent regression analyses.
Next, to test for moderation, the interaction between child maltreatment and the latent variable was added to the model. This final structural model showed good model fit: $x^2 = 53.46, \text{df} = 44, \ p > 0.05; \ \text{RMSEA} = 0.04; \ \text{CFI} = 0.97; \ \text{TLI} = 0.96$. Although maternal history of childhood maltreatment ($\beta = -0.11, \ t = -1.21, \ p = 0.23$) did not significantly contribute to the variance in cortisol reactivity in this model, moderation analyses revealed that difficulties with emotion regulation significantly moderated the association between maternal exposure to child maltreatment and cortisol reactivity ($\beta = -0.17, \ CI_{95} = -0.31, -0.04, \ t = -2.51, \ p = 0.01$). Medication use ($\beta = 0.13, \ t = 1.59, \ p = 0.11$), bedtime ($\beta = 0.15, \ t = 1.81, \ p = 0.07$), and ethnicity ($\beta = 0.16, \ t = 1.87, \ p = 0.06$) were dropped from this final moderation model as they became non-significant covariates. Additionally, in this final model, the latent variable of difficulties with emotion regulation was significantly correlated to maternal exposure to childhood maltreatment ($r = 0.31, \ p < 0.001$) and postpartum mood score ($r = 0.53, \ p < 0.001$).

Table 5

Final moderation model in which child maltreatment and latent difficulties with emotion regulation were examined in relation to cortisol reactivity (AUC$_I$).

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B (S.E.)</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Childhood Maltreatment</td>
<td>-.11(.09)</td>
<td>-1.21</td>
<td>.23</td>
</tr>
<tr>
<td>Difficulties with Emotion Regulation</td>
<td>.44(.21)</td>
<td>2.13</td>
<td>.03*</td>
</tr>
<tr>
<td>Interaction</td>
<td>-.17(.07)</td>
<td>-2.50</td>
<td>.01*</td>
</tr>
</tbody>
</table>

* $p < 0.05$ level.
**Figure 2.** Full model and results for the final moderation model in which child maltreatment and latent difficulties with emotion regulation were examined in relation to cortisol reactivity to psychosocial challenge.

*Note.* The oval represents the latent variable and the rectangles represent the observed variables. Standardized beta coefficients are reported; *p* < 0.05.
The Interaction Effect

The interaction effect of the latent difficulties with emotion regulation construct was produced using a LOOP plot in Mplus and simple slope analyses to interpret the interaction of continuous predictors (Aiken & West, 1991; MacKinnon & Fairchild, 2010). History of childhood maltreatment as a predictor of cortisol reactivity to psychosocial challenge was modeled at high and low levels of difficulties with emotion regulation (1+/− SD above/below the mean). At lower levels of emotion regulation difficulties, exposure to childhood maltreatment was unrelated to cortisol reactivity ($b = 0.19$, $t = 0.52$, $p = 0.60$). However, at higher difficulties with emotion regulation, exposure to child maltreatment was significantly related to cortisol reactivity ($b = -0.83$, $t = -2.75$, $p = 0.01$). As shown in Figure 3, women with higher reported levels of childhood trauma and greater difficulties with emotion regulation displayed decreased cortisol reactivity compared to women with higher childhood trauma scores and less difficulties with emotion regulation.
Figure 3. Level of maternal difficulties with emotion regulation (D-ER) moderating the relationship between childhood history of maltreatment (CTQ total score) and cortisol reactivity to psychosocial challenge (AUC; nmol/L).

**DISCUSSION**

There is substantial evidence to suggest that prolonged exposure to stress in childhood has long-term implications for emotional and physiological outcomes (Teicher & Samson, 2016; Thompson et al., 2014). The aim of this study was to extend this line of research, through examination of emotion regulation as a moderator between history of child maltreatment and cortisol response to challenge in a sample of postpartum women. Our findings demonstrated that maternal difficulties with emotion regulation moderated the impact of exposure to child maltreatment on time-dependent cortisol reactivity to an
Emotional Stroop task. More specifically, the significant interaction effect revealed that only women who reported higher levels of child maltreatment and greater difficulties with emotion regulation exhibited decreased cortisol reactivity to psychosocial challenge. These findings suggest that difficulties with emotion regulation may uniquely contribute to cortisol hyporeactivity in postpartum women exposed to higher levels of child maltreatment.

International prevalence estimates for self-reports of child abuse and neglect range from 11.8 –18.4%, depending on the type of maltreatment considered (Stoltenborgh, Bakermans-kranenburg, Ijzendoorn, & Alink, 2013; Stoltenborgh, van Ijzendoorn, Euser, & Bakermans-Kranenburg, 2011). We found similar estimates in the current sample, as 22.1% of women reported experiencing at least one type of maltreatment. The results of the current study are also consistent with other research showing that exposure to child maltreatment can contribute to emotion dysregulation and maladaptive strategy-use in adults (Soenke, Hahn, Tull, & Gratz, 2010; Stevens et al., 2013), as well as reduced cortisol reactivity in females (Carpenter et al., 2007; MacMillan et al., 2009; Trickett et al., 2010). We extended previous research by examining emotion regulation as a moderator of the magnitude and direction of cortisol reactivity to acute psychosocial challenge in postpartum women exposed to child maltreatment. Difficulties with emotion regulation have been previously linked to mood disorders and other functional difficulties in postpartum women (Haga et al., 2012). However, even after controlling for important individual characteristics, such as postpartum mood and medication use, we were still able to detect an altered cortisol response to challenge among women exposed to
maltreatment in childhood with current difficulties in emotion regulation. Therefore, the significant interaction between maltreatment experience and emotion regulation found in this study likely reveals a maladaptive mechanism that extends beyond maternal psychopathology. The interaction effect was contingent upon the level of emotion regulation ability, suggesting that exposure to higher levels of early trauma and greater difficulties regulating emotional responses have a cumulatively negative impact on physiological responsivity in postpartum women.

Emotion regulation serves to optimally match an individual’s emotional arousal with the level of challenge present in the environment (Thompson, 2008). When violence and stress are present in the early environment the development of adaptive emotion regulation is disrupted, and long-term difficulties responding to challenging and emotional situations can persist (Morris et al., 2007; Perlman et al., 2008). Exposure to early adversity can alter the development of systems responsible for responding to challenge and the circuitry of the prefrontal-limbic system and hypothalamus, which may be precursors to autonomic dysfunction and clinical psychopathology (Lovallo, 2011, 2013). Following exposure to chronic severe stress, dampened HPA axis reactivity to threat may actually serve to protect a maltreated individual from cortisol-related brain damage (Del Giudice et al., 2011; Gunnar & Quevedo, 2007). However, across the lifespan this can contribute to deficient cortisol production, or hypocortisolism, which leads to an increased vulnerability for stress-related bodily disorders, such as posttraumatic stress disorder and other somatoform disorders (Heim, Ehlert, & Hellhammer, 2000). Although the precise mechanisms through which early adversity
exerts its influence on the neuroendocrine system are not fully explicated, the current study provides evidence for blunted HPA reactivity in mothers with childhood history of maltreatment and difficulties in emotion regulation.

Blunted physiological reactivity is theorized to reflect a more general dampening of the various systems that perceive acute challenge, respond to challenge, and deal with motivation and emotion (Phillips et al., 2013). Individuals exposed to maltreatment can develop a maladaptive tendency to perceive threatening stimuli as less anomalous and dangerous, and this could result in reduced awareness and responsivity in challenging conditions (Pine et al., 2005). Additionally, repeated exposure to stress can impact the psychological systems that support motivation and emotion, so blunted reactivity may reflect motivational dysregulation (Carroll, Lovallo, & Phillips, 2009). This reduced capacity to respond to acute conditions of challenge could represent a disengagement of biological systems due to prolonged exposure to maltreatment. As described in the Adaptive Calibration Model (ACM; Del Giudice et al., 2011), an unemotional pattern of stress responsivity develops following exposure to severe or traumatic stress, and is characterized by low physiological reactivity across the HPA axis, parasympathetic nervous system, and sympathetic nervous system (Del Giudice et al., 2011). Furthermore, this stress response system encodes and filters incoming information in order to regulate behaviour in terms of learning, attachment, and reproductive functioning (Del Giudice et al., 2011). Thus, blunted cortisol reactivity to psychosocial challenge may reflect a larger tendency of maltreated women to dissociate from, instead of become vigilant towards, threat (Del Giudice et al., 2011; Phillips et al., 2013; Tarullo & Gunnar,
Moreover, in terms of the current sample of postpartum women, the unemotional physiological profile may have negative consequences for parenting behaviour and the mother-infant attachment relationship.

Further discussion of this theoretical framework in regards to the unique characteristics of the postpartum period is important, as physiological and emotional responsivity have significant implications for maternal behaviour (Azak & Raeder, 2013; Juul et al., 2016; Olza-Fernández, Marín Gabriel, Gil-Sanchez, Garcia-Segura, & Arevalo, 2014). Parental behaviour and motivation is supported by a complex system of psychological and endocrine factors, with HPA axis function being proposed as a primary mechanism through which early trauma influences maternal behaviour (Barrett et al., 2012). Research on neuroendocrine function in new mothers has revealed that cortisol dysregulation is associated with flattened emotional affect, insensitive parenting practices, and mother-child attachment insecurity (Juul et al., 2016; Roque, Veríssimo, Oliveira, & Oliveira, 2012; Schechter et al., 2004). However, the nature of this relationship for postpartum women exposed to child maltreatment represents a relatively new realm of investigation. One study reported that compared to postpartum women without a history of child abuse, new mothers with childhood history of abuse demonstrated steeper declines in cortisol reactivity to an infant-stressor paradigm (Brand et al., 2010). Additionally, recent research discovered that history of childhood trauma in postpartum women was associated with lower mean cortisol secretion, which in turn predicted increased neutral affect when interacting with their infant in a naturalistic context and an emotional stressor (Juul et al., 2016). In terms of maternal emotional
functioning, one study has suggested that depressive symptomology mediates the association between childhood history of maltreatment and parenting behaviour (Banyard, Williams, & Siegel, 2003). With recent evidence showing that maternal history of physical abuse places women at an increased risk of developing postpartum depression, which is in turn was associated with greater child difficulties with mood and affect regulation (Madigan et al., 2015). Further research is needed to determine the precise impact of the interconnected variables of maternal history of child maltreatment, reduced HPA axis responsivity, and impaired emotional functioning on maternal behaviour and child development.

In additional to reduced physiological reactivity, the unemotional responsivity pattern is theorized to inhibit social learning and sensitivity to social feedback (Del Giudice et al., 2011). These disruptions are thought to divergently affect males and females, with unemotional males engaging in more high-risk and competitive behaviours, and unemotional females displaying reduced cooperation and parental investment (Del Giudice et al., 2011). Consistent with these hypotheses are findings that many women exposed to childhood trauma develop avoidant coping strategies, which when they become parents themselves can manifest as reduced social-emotional expression and disengaged behaviours when interacting with their infant (Juul et al., 2015; Lyons-Ruth & Block, 1996). Avoidant strategies also influence the availability of attentional resources for detecting threatening stimuli (Stein et al., 2012; Williams et al., 1996), and this can negatively impact a mother’s attentiveness and responsiveness to her infant’s signals (Stein et al., 2012). Similarly, emotional dysregulation in postpartum women is believed
to impair the increased sensitivity to threat that is evolutionarily advantageous in helping to protect a young infant (Silverman et al., 2011). This has implications for child development, as maternal attentiveness to affective stimuli signals information to young children about their early environment, which can incur risk for the intergenerational transmission of emotional disorders (Waters et al., 2015). Presently, we do not know how the reported relationship between difficulties with emotion regulation and cortisol reactivity in women exposed to child maltreatment impacts parental behaviour, maternal attentiveness, and infant development. There is still insufficient understanding of how maltreatment experiences impact the emotion regulation capacities of adults, especially when they are becoming parents themselves (Kim & Cicchetti, 2010; Morris et al., 2007). Future research will help provide insight into the maternal and intergenerational impact of early trauma on emotional and physiological regulation.

Although not all individuals exposed to child maltreatment experience emotional or physiological dysregulation, evidence identifies them at high risk for both (Buist, 1998; Luke & Banerjee, 2013). Notably, there is a diversity and complexity in the maladaptive consequences associated with exposure to early adversity (Masten & Wright, 1998; Perez & Widom, 1994). Understanding the processes through which early trauma affects adult regulatory processes increases the likelihood of developing effective prevention and intervention programs. Attention and emotion regulation training have had success in reducing clinical symptomatology in panic disorder, major depression, and posttraumatic stress disorder (Papageorgiou & Wells, 2000; Wadlinger & Isaacowitz, 2011). Although evaluation of such approaches is ongoing, treatments that target areas aimed at improving
emotion regulation ability are an important avenue of exploration in regards to childhood trauma (Joormann & Quinn, 2014).

**Limitations**

The present findings should be considered in light of some potential limitations. Assessment of child maltreatment was completed by retrospective self-report, which is subject to bias and inaccurate recall of past events, although the likelihood of false negatives is low (Hardt & Rutter, 2004; Widom, Raphael, & Dumont, 2004). Additionally, only exposure to child maltreatment was assessed in this study, although experiences of maltreatment are diverse and can span across the life course (Masten & Wright, 1998; Perez & Widom, 1994). Previous work has shown that that recent life stressors can moderate the association between exposure to childhood adversity and HPA axis function (de Kloet et al., 2007); however, this study did not collect information pertaining to current life stressors. Emotion regulation was also assessed via measures of self-report, which are prone to social-desirability and reporting bias. However, as there is not currently a validated and standardized measure for behaviorally evaluating emotion regulation in adults, research should continue to explore naturalistic and ecological measures of emotion regulation (Heiy & Cheavens, 2014b; Seeley, Garcia, & Mennin, 2015). Another important consideration is that HPA axis activity was assessed through salivary cortisol response to an Emotional Stroop task. Previous research indicates that the Emotional Stroop, and other similar psychosocial challenges (e.g., the traditional colour-word interference Stroop and other cognitive tasks), stimulate intra-individual
variability in cortisol response (Dickerson & Kemeny, 2004; van Honk et al., 2000). However, other factors that may impact Emotional Stroop performance and subsequent physiological response patterns, like the speed-accuracy trade-off (Zimmerman, 2011), were not explored in the current design. Additionally, there are other factors known to influence cortisol reactivity, and although every effort was made to include relevant covariates, it is possible that other unmeasured variables like body mass index (Incollingo Rodriguez et al., 2015), mode of delivery during childbirth (Vogl et al., 2006), and unreported use of oral steroids and synthetic glucocorticoids (Krasowski et al., 2014) may influence this relationship. Future research on the same variables as evaluated by additional behavioural and biological measures and in more naturalistic contexts pertaining to conditions of challenge and stress is encouraged.

Conclusion

The present results suggest that emotion regulation has an important role in the association between exposure to early adversity and physiological reactivity to conditions of challenge. Specifically, difficulties with emotion regulation were associated with reduced cortisol reactivity in postpartum women exposed to higher levels of child maltreatment. This study bridges previous research on cortisol and emotional regulation, and suggests that difficulties with emotion regulation and cortisol blunting to psychosocial challenge develop as long-term sequelae of child maltreatment. Continued investigation into the associations between child maltreatment, emotion regulation,
psychopathology, and response to psychosocial challenge are crucial to better understanding the impact on new parents and formulating appropriate treatment options.
Chapter 3: Study 2

General Purpose

Prior work has examined the associations between childhood trauma and attention bias, with some research reporting that child abuse is associated with attentional allocation towards emotional cues (Pollak & Tolley-Schell, 2003; Romens & Pollak, 2012), and other work demonstrating a link between childhood trauma and attentional avoidance of emotional stimuli (Pine et al., 2005). Although the primary aim of the ACM is to define responsivity profiles across physiological systems, this framework also describes the implications of these profiles for attentional processes. Therefore, this framework may help explain the conflicting reports on the direction of attention bias found in individuals exposed to childhood trauma. In the ACM, the vigilant phenotype is described as having a high responsivity physiological profile that mediates increased attention to social-emotional and threat-related information (Del Giudice, Hinnant, Ellis, & El-Sheikh, 2012). On the other hand, the unemotional phenotype is described as having a low responsivity physiological profile that inhibits sensitivity to social-emotional information and initiates the blocking of threat-related information (Del Giudice et al., 2012). As previous research suggests that emotion regulation moderates attention to emotional information in children exposed to maltreatment (Romens & Pollak, 2012), the second objective of this thesis is to examine maternal emotion regulation capacity as a factor that differentiates between attentional responsivity profiles in postpartum women reporting greater exposure to childhood trauma.
Title, Authorship, and Copyright

**Title:** Attentional avoidance of emotional stimuli in postpartum women with childhood history of maltreatment and difficulties with emotion regulation

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**Conflicts of Interest:** None

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Abstract

Child abuse and neglect can lead to difficulties regulating responses to threatening and emotional situations. Exposure to childhood maltreatment has been linked to conflicting findings of both attention biases towards and away from threat-related information. The aim of the current study was to investigate if emotion regulation moderated the association between history of childhood maltreatment and attention bias in a sample of postpartum women. One hundred and forty women participated in the study at 7-months postpartum. Selective attention to both negative emotional and attachment-related negative emotional words was assessed using the emotional Stroop task. The latent variable of difficulties with emotion regulation was found to significantly moderate the association between history of childhood maltreatment and attention bias to both negative emotional ($\beta = -0.15$, $t = -2.04$, $p < 0.05$) and attachment-related emotional stimuli ($\beta = -0.16$, $t = -2.98$, $p < 0.05$). In women with higher childhood trauma scores, those with greater emotion regulation difficulties displayed decreased attention towards negative emotional and attachment-related emotional stimuli. In contrast, women reporting higher exposure to childhood maltreatment with greater emotion regulation capacity, displayed increased attention to negative emotional and attachment-related negative emotional stimuli. This study provides evidence for attentional avoidance of emotional material in postpartum women with greater experiences of maltreatment and difficulties with emotion regulation. As the postpartum period has significant implications for maternal well-being and infant development, these findings are discussed in terms of maternal responsiveness, sensitivity to threat, and the intergenerational transmission of risk.
Introduction

Experiences of child maltreatment are associated with persistent difficulties in both processing as well as regulating emotional responses (Thompson, Hannan, & Miron, 2014; Wingenfeld et al., 2011). Children and adults exposed to child maltreatment exhibit alterations in emotional reactivity, social-emotional understanding, and cognitive biases to emotional information (Luke & Banerjee, 2013). Attention biases encompass both attentional allocation and attentional avoidance of emotional material, and play a major role in the etiology and maintenance of many mental health and emotional disorders (MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002; Williams et al., 1996). Childhood maltreatment has been shown to contribute to the development of attention biases (Fani et al., 2011), as well as mood and anxiety disorders in adults (McCauley et al., 1997). However, the literature examining child maltreatment and attention biases reports mixed findings (Davis et al., 2014; Gibb et al., 2009). Moreover, the role of emotion regulation in exacerbating or attenuating these relations remains under-examined, particularly in women entering their childrearing years. The postpartum period poses a particular vulnerability for women in terms of mental health and emotional difficulties (Robertson et al., 2004). Therefore, the purpose of the current study was to investigate emotion regulation as a moderator of the association between attention bias and maternal history of child maltreatment. Investigating this relationship is particularly relevant during the postpartum period, as postpartum women with history of child maltreatment are at an increased risk of experiencing emotional dysfunction (Collishaw et
al., 2007; Sexton et al., 2015), which in turn impacts the mother-infant attachment relationship and infant development (Stein et al., 2008).

**Attachment, Emotion Regulation, and Maltreatment**

Attachment theory stipulates that many regulatory functions develop based on early experiences with attachment figures, and it is largely within the parent-child relationship that young children learn to strategically regulate their emotions (Bowlby, 1989; Dykas & Cassidy, 2011). For abused or neglected children, often their early environment is not one of warmth and support, which can lead to disruptions in attachment bonds and subsequent impairments in emotion regulation (Bowlby, 1982; Cicchetti & Toth, 1995). Maltreated children display a lowered tolerance for negative emotions and employ more maladaptive emotion regulation strategies, which further disrupts emotional processing (Pollak & Tolley-Schell, 2003). These maladaptive tendencies can persist into adulthood, as adults exposed to childhood maltreatment are reported to experience difficulties empathizing and regulating their emotional experiences (Cloitre et al., 2008; Paivio & Laurent, 2001; Shipman et al., 2005). Despite the growing literature on the consequences of child maltreatment for precise elements of emotional reactivity, the enduring impact of maltreatment on the processing and regulation of emotional information in women entering their childrearing years is relatively unexplored.
Attention Bias and Childhood Maltreatment

Although attention biases have been studied extensively in regards to psychopathology, research has only begun to delineate the impact of child maltreatment on attention bias (da Silva Ferreira, Crippa, & de Lima Osório, 2014; Romens & Pollak, 2012). Exposure to maltreatment has been linked with altered attention to emotional stimuli in both children and adults (Davis et al., 2014; Pine et al., 2005; Pollak & Tolley-Schell, 2003). However, the literature reports mixed results on the direction of this relationship; with some studies reporting that maltreatment is associated with increased attention towards emotional stimuli (Gibb, Schofield, & Coles, 2009; Pollak & Tolley-Schell, 2003), and other studies reporting that maltreatment is associated with decreased attention towards emotional stimuli (Davis et al., 2014; Pine et al., 2005). Investigation of attention bias using the dot-probe task has revealed that maltreated children display increased attention towards facial expressions of anger (Pollak & Tolley-Schell, 2003), and that young adults with histories of moderate to severe maltreatment also show increased attention to angry and sad faces (Gibb et al., 2009). In contrast with these findings, maltreated children with concurrent posttraumatic stress disorder display decreased attention to threatening faces (Pine et al., 2005), and adults with histories of maltreatment and attachment anxiety display attention bias away from threatening faces (Davis et al., 2014).

Several studies have documented an association between maltreatment and attention bias as indexed using the Emotional Stroop paradigm. Specifically, exposure to childhood trauma is associated with attentional bias as reflected in response latencies to
emotionally-valenced words in adults (Wingenfeld et al., 2011), response latencies to fearful facial experiences in postpartum women (Choi et al., 2017), and enhanced interference to personally-relevant and emotional words in children and adults (McNally, Clancy, & Schacter, 2001; Puetz et al., 2016). Traditionally, attentional allocation towards cues of anger during selective attention tasks has been theorized to reflect an increased sensitivity to threatening information in order to help victims of abuse avoid a situation with the potential for violence (Cicchetti, Rogosch, Gunnar, & Toth, 2010; Pollak & Tolley-Schell, 2003). Thus, attention bias towards positive emotional cues is commonly accepted to indicate adaptive emotion regulation, whereas attention bias towards negative emotional cues is thought to signal maladaptive emotion regulation (Joormann & Gotlib, 2007). However, recent work has proposed that the nature of psychopathological symptomatology may be associated with the direction of attention bias towards or away from emotional stimuli (Chen, Ehlers, Clark, & Mansell, 2002; Pine et al., 2005). Therefore, increased attendance to positive cues or decreased attendance to negative cues may reflect a maladaptive tendency to avoid cues that are perceived as threatening (Lee, Kang, Park, Kim, & An, 2008; Waters & Kershaw, 2015). As emotion regulation buffers against threat as a part of an interactive stress-response system that modulates arousal and attentional engagement (Thompson, 2008), these cumulative findings suggest that emotion regulation capacity may serve as a determinant in attentional vigilance and avoidance of threat.

In order to help resolve the inconsistent findings on attention bias in maltreated populations, Davis and colleagues (2014) recommended investigating potential
moderating variables. Previous research has shown that trait rumination, a maladaptive emotion regulation strategy, moderates attention bias in maltreated children at-risk for depression (Romens & Pollak, 2012). Furthermore, other factors strongly related to emotion regulation, like attachment representations, have been shown to moderate attention bias in adults with childhood history of maltreatment (Davis et al., 2014). However, no prior work has evaluated the interaction between maternal history of child maltreatment and emotion regulation on attention bias. As recent work suggests that attention bias may serve as an intergenerational mechanism through which maternal childhood history of maltreatment impacts infant development (Choi et al., 2017), examining emotion regulation as a moderator of attention bias in postpartum women is an important avenue of exploration for both maternal and infant health.

**Theoretical Perspectives on Emotion Regulation**

Emotion regulation comprises a wide variety of processes that aim to monitor, evaluate, and modify emotional responses (Thompson, 2008). Research investigating emotion regulation often diverges along conceptual lines based on a specific theoretical model of emotion regulation; considering either the process model through use of the Emotion Regulation Questionnaire (ERQ; Gross & John, 2003) or the emotional competency model through use of the Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004). The process model stipulates that emotion regulation involves recruitment of one or more strategies that influence the nature of the emotional response, either through acting on the antecedent of an emotional response or the emotional
response itself (Gross & Barrett, 2011; Gross & Thompson, 2007). Expressive suppression is an example of a response modification strategy, where a behavioural attempt is made to reduce an emotional response that is already underway (i.e., concealing an emotional outburst to an upsetting event) (Gross, 1998; Gross & Levenson, 1997). An example of an antecedent-focused strategy is cognitive reappraisal, where mental resources are mobilized in order to modify how an emotional event will be interpreted before an emotional response arises (i.e., trying to think about a potentially emotional event in a non-emotional way) (Gross, 1998).

Although emotion regulation strategies contribute to emotional experience, they are only a facet of the broad range of abilities that encompass emotion regulation capacity. The emotional competency model defines emotion regulation as multidimensional through evaluating more global skills (Dixon-Gordon et al., 2014; Gratz & Roemer, 2004). Within this structure, emotion dysregulation comprises deficits in the awareness and understanding of emotional experience, non-acceptance of emotions, limited access to strategies that manage emotions, and inability to regulate impulsivity and accomplish goals (Aldao & Dixon-Gordon, 2014; Gratz & Roemer, 2004; Salsman & Linehan, 2012). Recent work has provided evidence that both the process and the emotional competency models assess distinct, but related, aspects of emotion regulation (Bardeen & Fergus, 2014; Ehring & Quack, 2010; Tull & Aldao, 2015). Particularly, the process model assesses use of specific strategies that allow individuals to modulate their emotional reactions, and the emotional competency model measures general capability to strategically regulate emotions (Bardeen & Fergus, 2014). As previous research has
recommended that emotion regulation capacity need to be considered more comprehensively (Aldao & Dixon-Gordon, 2014; Aldao & Nolen-Hoeksema, 2012), this study adopted an inclusive approach and simultaneously assessed emotion regulation across both theoretical perspectives.

Specifically, this project investigates how the level of emotion regulation capacity influences the relationship between childhood history of maltreatment and attention bias to negative emotional stimuli in postpartum women. To address how experiences of childhood maltreatment may influence the emotional functioning and behavioural responsivity of postpartum women we have turned to the Adaptive Calibration Model (ACM) of stress reactivity (Del Giudice, Ellis, & Shirtcliff, 2011). The ACM proposes that individual responsivity is primarily determined by conditional adaption, and developing in a stressful environment as a child can lead to diverse patterns of responsivity in adulthood (Del Giudice et al., 2011). Within this model, responsivity profiles that develop following exposure to childhood trauma range from vigilant phenotypes that display increased attention towards threatening stimuli, to unemotional phenotypes that exhibit avoidance of threat-related information (Del Giudice et al., 2011). Thus, these two divergent responsivity patterns may reflect different directions of attention bias, either attentional vigilance or avoidance of threat, as a function of emotional regulation capacity.
The Present Study

Women are particularly vulnerable to emotional dysfunction during the postpartum period, as 10-15% of women will develop postpartum depression and many more will experience emotional difficulties (Robertson et al., 2004). During the postnatal period there are several factors which increase the risk of emotional disturbance, including: low levels of social support, difficulties breastfeeding, and history of childhood maltreatment (Collishaw et al., 2007; Grekin & O’Hara, 2014; Haga et al., 2012; O’Hara & Swain, 1996; Sexton et al., 2015). New mothers experience a wide range of both positive and negative emotions, and a woman’s emotion regulation capacity greatly influences her well-being and ability to cope with the demands of parenthood (Haga et al., 2012; Neumann, Krömer, & Bosch, 2005). Previous research has revealed that greater use of maladaptive emotion regulation strategies (e.g., rumination, self-blame, catastrophizing) predicts higher postpartum depression scores; whereas, greater use of positive emotion regulation strategies (e.g., cognitive reappraisal/reinterpretation, concentration on planning) is related to lower levels of depressive symptomology (Haga et al., 2012).

To our knowledge, the impact of emotion regulation capacity on attentional processing in postpartum women with childhood history of maltreatment has never been explored. Therefore, the aim of the current study was to use structural equation modeling to explore a latent construct of emotion regulation as a potential moderator in the association between maternal exposure to childhood maltreatment and attention to emotional stimuli. We postulate that in postpartum women with experiences of early
trauma the level of emotion regulation capacity will determine the direction of attention to emotional information. Specifically, we hypothesize that emotion regulation capacity will moderate attention bias during an Emotional Stroop task, differentiating between the two responsivity profiles described in the ACM that develop following exposure to highly stressful childhood contexts. In new mothers exposed to childhood maltreatment, we hypothesize that women reporting strengthened emotion regulation capacity will display a vigilant phenotype characterized by increased attention towards emotional information, and that women reporting greater difficulties with emotion regulation will display an unemotional phenotype characterized by attentional avoidance of emotional information. Findings from this work have potential implications for the well-being of new mothers and the early foundations of the mother-infant attachment relationship.

Materials & Methods

Sample and Procedure

Participants included a community sample of 140 new mothers aged 22 to 41 years (M = 32.3, SD = 4.4), who were recruited from the maternity ward at St. Joseph’s Healthcare Hamilton, Ontario. In the current sample, 12.9% of women reported belonging to a visible minority. Participants were primarily in spousal relationships (72.9%) and university educated (67.9%). The median family income was between $92,000 - $113,999 Canadian dollars. Study inclusion criteria included: a) mothers to be age 18-years or older at the time they gave birth; b) mothers to have given birth at full-
term to a healthy infant; c) mothers to be able to access their infants at the time of the home visits; and d) mothers to have the ability able to read, write, and speak English. Exclusion criteria included any characteristics that would not permit participants to complete the research measures, such as cases of severe physical disability and language barriers. Written, informed consent was obtained for all study participants. The McMaster Research Ethics Board and the St. Joseph’s Healthcare Research Ethics Board approved the study protocol.

Data collection was conducted from May 2013 until December 2014 by a research team at the Offord Centre for Child Studies. Women who consented to participate completed two 2-hour home visits between the hours of 1000hr and 1600hr at 3-months postpartum and again at 7-months postpartum. During the 3-month home visit mothers were assessed on their exposure to childhood maltreatment and demographic factors. During the 7-month home visit mothers were assessed on their emotion regulation, postpartum mood, and selective attention to emotional stimuli during the Emotional Stroop task. At the time of the 7-month postpartum visit, 67.1% of women were breastfeeding, and 65.7% weren’t currently on any prescription medications (9.3% were on anti-depressants, 8.6% oral contraceptives, 6.4% thyroid medication, 3.6% lactation aids).
**Measures**

**Childhood Trauma Questionnaire (CTQ).** The CTQ (Bernstein & Fink, 1998) is a 28-item self-report questionnaire that evaluates types and frequency of abuse and neglect using a 5-point Likert scale (1 = never; 5 = very often). Using established moderate-severe cutoff scores from the CTQ (Bernstein & Fink, 1998), in the present sample 15.1% of women reported experiencing emotional abuse, 12.9% reported sexual abuse, 7.2% reported physical abuse, 4.3% reported physical neglect, and 0.7% reported emotional neglect. Overall, 21.7% of women reported experiencing at least one subtype of moderate-severe childhood abuse. These proportions are comparable to international prevalence figures of maltreatment, with recent meta-analyses reporting estimates ranging from 11.8-18.4%, depending on the subtype of abuse or neglect considered (Stoltenborgh, Bakermans-Kranenburg, & van IJzendoorn, 2013; Stoltenborgh et al., 2011). The CTQ also provides a composite score of overall maltreatment experience, which was used as a continuous variable for the purpose of statistical analyses (M = 28.0, SD = 12.3). The CTQ has demonstrated strong psychometric properties in both clinical and community samples, and in relation to other retrospective maltreatment assessment tools (Paivio & Cramer, 2004; Scher et al., 2001). In the present sample, the abuse and neglect subscales from the CTQ had acceptable internal consistency estimates (0.72 ≥ Cronbach’s $\alpha$ ≤ 0.96) and the composite score also had good internal consistency (Cronbach’s $\alpha = 0.80$).

**Emotion Regulation Questionnaire (ERQ).** The ERQ (Gross & John, 2003) is a
10-item self-report questionnaire that assesses levels of two emotion regulation strategies, expressive suppression and cognitive reappraisal. Participants answered items on a seven-point Likert scale \((1 = \text{strongly disagree}; 7 = \text{strongly agree})\) and items were grouped together into composite variables for each trait strategy. The ERQ has been found to possess strong internal consistency for both trait reappraisal (Cronbach’s \(\alpha = 0.82\)) and trait suppression (Cronbach’s \(\alpha = 0.76\)) (Wiltink et al., 2011). In the current study, the ERQ was also found to have acceptable internal consistency for both trait reappraisal (Cronbach’s \(\alpha = 0.84\)) and trait suppression (Cronbach’s \(\alpha = 0.72\)).

**Difficulties in Emotion Regulation Scale (DERS).** The DERS (Gratz & Roemer, 2004) is 36-item self-report questionnaire that assesses an individual’s general difficulties at regulating their emotions across six dimensions. These dimensions include: non-acceptance of negative emotions, difficulties engaging in goal-directed behaviours when distressed, difficulties controlling impulsive behaviours when experiencing negative emotions, limited access to emotion regulation strategies perceived as effective, lack of emotional awareness, and lack of emotional clarity. Participants rated items on a five-point Likert scale \((1 = \text{almost never}; 5 = \text{almost always})\). Total scores from each of these six dimensions of emotion dysregulation were calculated and used in statistical analyses. The DERS has been found to have strong overall internal consistency for all 36 items and adequate internal consistency for each of the six subscales (Gratz & Roemer, 2004; Neumann, van Lier, Gratz, & Koot, 2010). In the current study, the DERS possessed high overall internal consistency (Cronbach’s \(\alpha = 0.83\)) and acceptable internal
consistency for each subscale ($0.70 \geq \alpha \leq 0.86$).

**Edinburgh Postnatal Depression Scale (EPDS).** The EPDS (Cox, Holden and Sagovsky, 1987) is a 10-item screening tool used to assess depressive and anxious symptomology in postpartum populations. Cutoff scores are often used to categorize women who are at risk for developing postpartum depression (scores of 9-10) or who display moderate to severe levels of postpartum depression symptomology (scores of 11-15+), but there is considerable variation in cutoffs used across studies (Eberhard-Gran et al., 2003). In the present sample, 18.6% of women had an EPDS score ($\geq 9$). For the purpose of this study, EPDS score was used as a continuous covariate in the moderation analyses ($M = 5.9, SD = 4.2$). Past research has shown the EPDS to have high sensitivity, specificity, and reliability (Matijasevich et al., 2014; Zhong et al., 2014). In the present sample, EPDS items had high internal consistency ($\alpha = 0.84$).

**Selective Attention Task**

**The Emotional Stroop** paradigm demonstrates how performance is disrupted as a result of selective attention to emotional stimuli. The Emotional Stroop task is a clinically-relevant adaptation of the original Stroop procedure, where the emotional significance of word stimuli is varied so as to study the interference of emotionally salient words on colour naming (Williams et al., 1996). This Emotional Stroop paradigm was selected as it has been previously shown to engage emotional response systems and
evaluate attention bias in related populations (Atkinson et al., 2009; Hänsel & Von Känel, 2013; Mujica-Parodi, Greenbag, Kilpatrick, Greenberg, & Kilpatrick, 2007). The paradigm used in the present study was a 17-minute computerized task programmed using E-Prime 2.0 (Psychology Software Tools, 2015). The Emotional Stroop task included neutral words (e.g. ‘pattern’, ‘atmosphere’), negative emotional words (e.g. ‘disease’, ‘danger’), and attachment-related negative emotional words (e.g. ‘betray’, ‘abandon’). For the comprehensive list of test stimuli used refer to Table 1.

The task required participants to correctly indicate the font colour of presented word stimuli by pressing keyboard buttons. All word stimuli were presented in the center of the computer screen in size 22 font. Prior to each stimulus presentation, a target “+” sign flashed on screen for 500ms to help orient the participant. Before beginning the test phase, participants completed a 90-second practice test with 20 neutral word stimuli not included in the test phase word list (e.g. “one”, “two”, “three”, “four”) in order to become familiar with instructions. Following this practice test, participants immediately completed the test phase which lasted 15-minutes and involved 240 stimuli presentations. Stimuli were presented on screen for 500ms each, and were presented in a random order, with the restriction that the same word or font colour would not appear twice in succession. The interstimulus interval was 3000ms. Participant response latencies were recorded continuously by the computer throughout the duration of the task. Using reaction time data from this task, average response latencies were computed for each word category (neutral, negative, attachment-related) and attention bias scores (negative, attachment-related) were calculated.
Table 1

Emotional Stroop stimuli.

<table>
<thead>
<tr>
<th>Neutral Words</th>
<th>Negative Words</th>
<th>Attachment-Related Words</th>
</tr>
</thead>
<tbody>
<tr>
<td>actual</td>
<td>angry</td>
<td>abandon</td>
</tr>
<tr>
<td>alphabet</td>
<td>ashamed</td>
<td>abuse</td>
</tr>
<tr>
<td>atmosphere</td>
<td>brutal</td>
<td>affair</td>
</tr>
<tr>
<td>average</td>
<td>chaos</td>
<td>alone</td>
</tr>
<tr>
<td>carbon</td>
<td>criticism</td>
<td>betray</td>
</tr>
<tr>
<td>concept</td>
<td>danger</td>
<td>breakup</td>
</tr>
<tr>
<td>content</td>
<td>depression</td>
<td>conflict</td>
</tr>
<tr>
<td>definition</td>
<td>destroy</td>
<td>deceit</td>
</tr>
<tr>
<td>domain</td>
<td>disease</td>
<td>divorce</td>
</tr>
<tr>
<td>employ</td>
<td>distress</td>
<td>grief</td>
</tr>
<tr>
<td>exact</td>
<td>disturb</td>
<td>insecure</td>
</tr>
<tr>
<td>margin</td>
<td>dumb</td>
<td>isolation</td>
</tr>
<tr>
<td>melon</td>
<td>frown</td>
<td>jealous</td>
</tr>
<tr>
<td>neutral</td>
<td>gloomy</td>
<td>lonely</td>
</tr>
<tr>
<td>paste</td>
<td>greedy</td>
<td>loss</td>
</tr>
<tr>
<td>pattern</td>
<td>illegal</td>
<td>neglect</td>
</tr>
<tr>
<td>premise</td>
<td>irritation</td>
<td>reject</td>
</tr>
<tr>
<td>railroad</td>
<td>mistake</td>
<td>selfish</td>
</tr>
<tr>
<td>roof</td>
<td>pathetic</td>
<td>separation</td>
</tr>
<tr>
<td>secretary</td>
<td>unfair</td>
<td>unfaithful</td>
</tr>
</tbody>
</table>
**Attention Bias Scoring.** Only response latencies from correct responses were analyzed, and the percentage of errors of omission and commission was low (< 5%). Based on recommended practices, test trials with response times either three standard deviations above or below the mean, which included test trials either < 100ms or > 1500ms, were excluded from analysis as they likely reflected inattention to the task (Mogg et al., 1995). Following data cleaning, average reaction times for each participant were calculated for each type of word category (neutral, negative emotional, and attachment-related emotional). In order to correct for non-normality, a logarithmic transformation was applied to the average reaction time data. Attention bias scores were then calculated using the transformed reaction time data, following which all data derived from the Emotional Stroop task were normally distributed.

Using the standard procedure, attention bias scores were computed by subtracting the average reaction time of the neutral word category from the average reaction time of the emotional word category (McHugh et al., 2010; Williams et al., 1996). As such, positive values for attention bias scores indicate increased attention towards emotional stimuli relative to neutral stimuli, while negative values indicate decreased attention to emotional stimuli relative to neutral stimuli. Therefore, in the current study, positive attention bias scores indicate longer response latencies towards attachment-related and negative emotional stimuli. Whereas, negative attention bias scores indicate shorter responses latencies towards attachment-related and negative emotional stimuli. Descriptive statistics are reported for the non-transformed attention bias scores, however, correlation and regression analyses were completed using transformed attention bias scores.
scores. Transformed attention bias scores for attachment-related emotional stimuli and negative emotional stimuli were used as continuous outcome measures in analyses investigating the influence of emotion regulation on the association between childhood history of maltreatment and attention to emotional information.

**Statistical Analyses**

*Missing Data.* Of the entire sample (N = 140), 3 participants were missing data pertaining to the Emotional Stroop task (did not complete/incomplete computerized task). Otherwise, 97.9% (n = 137) had complete data on the other variables of interest (e.g. socioeconomic status, postpartum mood, history of childhood maltreatment, emotion regulation subscale scores, etc.). The pattern of missingness was assessed using Little’s Missing Completely at Random (MCAR) test, $x^2 (27) = 25.72, p > 0.05$, which suggested that data did not significantly deviate from an MCAR pattern. Missing information was imputed for all variables using imputation techniques in Mplus 7 (Muthén & Muthén, 1998-2012.) Following recommended procedures, 10 data files were imputed using expectation maximization methods, and then pooled estimates were used for descriptive analysis and structural equation modeling (Asparouhov & Muthén, 2010; Graham, 2008).

*Measurement Model of ‘Difficulties with Emotion Regulation’.* The present study investigated emotion regulation as a latent construct composed of assessments from both the ERQ and DERS. The DERS subscale scores are widely accepted as indicators of
emotion dysregulation, where higher scores denote greater difficulties with emotion regulation (Gratz & Roemer, 2004). Conversely, the two trait strategies scores derived from the ERQ are considered as divergently advantageous. Conventionally, higher scores on the expressive suppression subscale are considered to signal maladaptive emotion regulation and higher scores on the cognitive reappraisal subscale are considered to indicate adaptive emotion regulation (Gross, 1998; Mauss et al., 2007). Recent research has used the reverse-scored subscale of cognitive reappraisal from the ERQ to indicate difficulties in emotion regulation (Scott et al., 2013). Therefore, the six subscale scores from the DERS, the expressive suppression subscale score from the ERQ, and the reverse-scored cognitive reappraisal scale from the ERQ were collectively considered in a latent variable of difficulties with emotion regulation.

**Structural Equation Model (SEM).** A latent variable moderated SEM was selected because it allows for increased effectiveness in assessing interactions between complex psychological concepts and statistical efficiency as it reduces parameter estimation (Klein & Moosbrugger, 2000; Maslowsky, Jager, & Hemken, 2015). The principal analytical approach sought to determine whether and how the latent construct of difficulties with emotion regulation would interact with maternal history of childhood maltreatment to predict attention to emotional information. These main analyses were completed in Mplus 7 (Muthén & Muthén, 1998-2012.). The measurement model of the latent variable was evaluated using the standard recommended indices of model fit: the Chi-square test ($\chi^2$), Root Mean Square Error of Approximation (RMSEA), Comparative
Fit Index (CFI), and Tucker Lewis Index (TLI). In order for a model to be accepted as consistent with the data, the $x^2$ test should be non-significant, the RMSEA value should be below 0.06, and the CFI and TLI values should be above 0.95 (Hu & Bentler, 1998; Kline, 2011).

Results

Demographics & Model Evaluation

Data pertaining to sociodemographic characteristics, childhood history of maltreatment, postpartum mood, emotion regulation, and attention to Emotional Stroop stimuli for all participants (N = 140) are reported in Table 2 and Table 3. Bivariate correlations amongst study variables are reported in Table 4.
Table 2

Sociodemographic characteristics.

<table>
<thead>
<tr>
<th>Variable</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visible Minority</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>12.9</td>
</tr>
<tr>
<td>Marital Status</td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>5.7</td>
</tr>
<tr>
<td>Married</td>
<td>72.9</td>
</tr>
<tr>
<td>Living Common Law</td>
<td>20.0</td>
</tr>
<tr>
<td>Separated or Divorced</td>
<td>1.4</td>
</tr>
<tr>
<td>Education</td>
<td></td>
</tr>
<tr>
<td>At least secondary school (Gr. 9-13)</td>
<td>10.0</td>
</tr>
<tr>
<td>College</td>
<td>22.1</td>
</tr>
<tr>
<td>University</td>
<td>40.0</td>
</tr>
<tr>
<td>Postgraduate</td>
<td>27.9</td>
</tr>
<tr>
<td>Household Income</td>
<td></td>
</tr>
<tr>
<td>&lt; $20,000</td>
<td>2.9</td>
</tr>
<tr>
<td>$20,000 - 34,999</td>
<td>7.1</td>
</tr>
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<td>$35,000 - 69,999</td>
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</tr>
<tr>
<td>$70,000 - 91,999</td>
<td>21.5</td>
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<tr>
<td>$92,000 - 113,999</td>
<td>30.7</td>
</tr>
<tr>
<td>$114,000 - 149,000</td>
<td>14.1</td>
</tr>
<tr>
<td>$150,000+</td>
<td>17.8</td>
</tr>
</tbody>
</table>
Table 3

Descriptive statistics for study variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTQ Total Score</td>
<td>27.87 (12.16)</td>
</tr>
<tr>
<td>EPDS Total Score</td>
<td>5.91 (4.20)</td>
</tr>
<tr>
<td>Cognitive Reappraisal Reversed Score</td>
<td>18.84 (6.70)</td>
</tr>
<tr>
<td>Expressive Suppression Score</td>
<td>10.77 (4.69)</td>
</tr>
<tr>
<td>Non-acceptance of Negative Emotions</td>
<td>16.10 (2.44)</td>
</tr>
<tr>
<td>Difficulties with Goal-Directed Behaviours</td>
<td>14.51 (1.70)</td>
</tr>
<tr>
<td>Impulsive Behaviours</td>
<td>11.87 (2.66)</td>
</tr>
<tr>
<td>Lack of Emotional Awareness</td>
<td>20.96 (2.90)</td>
</tr>
<tr>
<td>Limited Effective Emotion Regulation Strategies</td>
<td>19.03 (3.43)</td>
</tr>
<tr>
<td>Lack of Emotional Clarity</td>
<td>11.11 (1.74)</td>
</tr>
<tr>
<td>Average Neutral Word Reaction Time (ms)</td>
<td>829.52(128.46)</td>
</tr>
<tr>
<td>Average Negative Word Reaction Time (ms)</td>
<td>829.55 (127.12)</td>
</tr>
<tr>
<td>Average Attachment Word Reaction Time (ms)</td>
<td>833.25 (129.43)</td>
</tr>
<tr>
<td>Negative Attention Bias</td>
<td>.75 (24.10)</td>
</tr>
<tr>
<td>Attachment Attention Bias</td>
<td>3.01 (31.88)</td>
</tr>
</tbody>
</table>
### Table 4

Pearson correlations amongst covariates and outcome variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Marital Status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.26*</td>
</tr>
<tr>
<td>3. Household Income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.50*</td>
<td>.30*</td>
</tr>
<tr>
<td>4. EPDS Score</td>
<td>.21*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. CTQ Score</td>
<td>.21*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.13</td>
<td>-.10</td>
</tr>
<tr>
<td>6. Average Neutral Word Reaction Time</td>
<td></td>
<td>.11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.04</td>
<td>-.05</td>
</tr>
<tr>
<td>7. Average Negative Word Reaction Time</td>
<td></td>
<td>.11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.03</td>
<td>-.07</td>
</tr>
<tr>
<td>8. Average Attachment Word Reaction Time</td>
<td></td>
<td>.19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.00</td>
<td>-.11</td>
</tr>
<tr>
<td>9. Negative Attention Bias (transformed)</td>
<td></td>
<td>.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.06</td>
<td>-.11</td>
</tr>
<tr>
<td>10. Attachment Attention Bias (transformed)</td>
<td></td>
<td>.16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.14</td>
<td>-.24*</td>
</tr>
</tbody>
</table>

* $p < 0.05$ level.

Additionally, the bivariate correlations amongst emotion regulation subscale scores and the measurement model of the latent construct were assessed. There were multiple significant Pearson correlations between the different subscale scores ($0.18 \geq r \leq 0.39; p < 0.05$), which were accounted for in the measurement model. The first-order measurement model of the latent construct of difficulties with emotion regulation construct included 8 indicators: the 6 subscale scores from the DERS, the expressive suppression score from the ERQ, and the reverse-scored cognitive reappraisal score from the ERQ. Based on the recommended indices (Hu & Bentler, 1998; Kline, 2011), the
measurement model of the latent variable showed good model fit: $\chi^2 = 13.78$, $df = 11$, $p > 0.05$; RMSEA = 0.04; CFI = 0.99; TLI = 0.97.

**Structural Equation Models: Moderation Analyses**

Two separate moderation models were constructed to examine whether maternal exposure to childhood maltreatment, emotion regulation, and their interaction predicted attention to emotional stimuli during the Emotional Stroop. One model evaluated the influence of these factors on attention bias to *negative* emotional stimuli, and the other on attention bias to *attachment-related* emotional stimuli. Predictors were entered in a stepwise fashion to assess their ability to predict variance in attention bias scores. To test for significant covariates, bivariate correlations between maternal characteristics and the Emotional Stroop data were examined, and then significant relationships were considered in the initial regression models. Covariates included EPDS score, demographic variables (ethnicity, marital status, educational attainment, household income), and other relevant characteristics (parity status, sleep quantity, breastfeeding status, medication use). Of these, only household income ($\beta = -0.20$, $t = -1.89$, $p = 0.06$) was close to significantly contributing to the variance in attention bias to attachment-related emotional words. The other non-significant covariates were dropped from the subsequent regression analyses.

Next, to test for moderation, maternal history of childhood maltreatment, the latent variable of difficulties with emotion regulation, and the interaction between childhood maltreatment and the latent variable were added into the model. The interaction was significant, and the latent construct of difficulties with emotion regulation
significantly moderated the association between maternal exposure to childhood maltreatment and attention bias to both negative emotional words ($\beta = -0.15$, $CI_{95} = -0.30$ to -0.01, $t = -2.04$, $p = 0.04$) and attachment-related emotional words ($\beta = -0.16$, $CI_{95} = -0.31$ to -0.02, $t = -2.26$, $p = 0.02$). Household income became a significant predictor of the variance in attention bias to attachment-related emotional words ($\beta = -0.24$, $t = -2.98$, $p = 0.03$). Additionally, in the final models for both attention bias to negative emotional words and attachment-related emotional words, the latent variable of difficulties with emotion regulation was significantly correlated with postpartum mood score ($r = 0.57$, $p < 0.01$). The latent variable of difficulties with emotion regulation was not significantly correlated with maternal history of childhood maltreatment ($r = 0.12$, $p > 0.05$).
Figure 1. Structural model and results for the final moderation model in which childhood maltreatment and latent difficulties with emotion regulation were examined in relation to attention bias to negative emotional words.

Note. The oval represents the latent variable and the rectangles represent the observed variables. Standardized beta coefficients and correlations are reported; *p < 0.05.

Non-Acceptance_DERS = non-acceptance of negative emotions from the DERS-II; Goal-Directed_DERS = difficulties engaging in goal-directed behaviour from the DERS-II; Impulsive_DERS = difficulties controlling impulsive behaviours from the DERS-II; Strategies_DERS = limited effective emotion regulation strategies from the DERS-II; Awareness_DERS = lack of emotional awareness from the DERS-II; Clarity_DERS = lack of emotional clarity from the DERS-II; Reappraisal = reverse-scored trait reappraisal from the ERQ; and Suppression_ERQ = trait suppression from the ERQ.
Figure 2. Structural model and results for the final moderation model in which childhood maltreatment and latent difficulties with emotion regulation were examined in relation to attention bias to attachment-related negative emotional words.

Note. The oval represents the latent variable and the rectangles represent the observed variables. Standardized beta coefficients and correlations are reported; \(^* p < 0.05\)

Non-Acceptance_DERS = non-acceptance of negative emotions from the DERS-II; Goal-Directed_DERS = difficulties engaging in goal-directed behaviour from the DERS-II; Impulsive_DERS = difficulties controlling impulsive behaviours from the DERS-II; Strategies_DERS = limited effective emotion regulation strategies from the DERS-II; Awareness_DERS = lack of emotional awareness from the DERS-II; Clarity_DERS = lack of emotional clarity from the DERS-II; Reappraisal_ERQ = reverse-scored trait reappraisal from the ERQ; and Suppression_ERQ = trait suppression from the ERQ.
The Interaction Effect: Johnson-Neyman Technique

The interaction effect was evaluated using a LOOP plot in Mplus and the Johnson-Neyman technique to examine significant interactions between continuous predictors (Hayes & Matthes, 2009; Johnson & Neyman, 1936). The Johnson-Neyman technique was used to examine how the latent construct of difficulties with emotion regulation moderated the relationship between childhood maltreatment and attention bias by plotting regions of significance. This was evaluated separately for attention bias to negative and attachment-related emotional words. Regions of significance refer to the value range of the latent construct in which childhood history of maltreatment had significant effects on attention. Referring to the 95% confidence interval determines the regions of significance, as this represents that range of the moderator within which the simple slope of $y$ on $x$ is significantly different from zero (Bauer & Curran, 2005; Hayes & Matthes, 2009; Preacher, Curran, & Bauer, 2006). For our purposes, the $y$-axis shows the slope of maltreatment on attention bias and the $x$-axis shows continuous levels of the moderating variable, difficulties with emotion regulation.

For low difficulties with emotion regulation (value = -1.05, $M = 0$), the slopes of maltreatment on negative attention bias were significant, as the 95% confidence interval did not enclose the value of zero. For high difficulties with emotion regulation (value = 1.80, $M = 0$), the slopes of maltreatment on negative attention bias were significant (see Figure 3). This pattern was similar for the impact of the latent construct in terms of attachment-related attention bias: for low difficulties with emotion regulation (value = -1.20, $M = 0$), the slopes of maltreatment on attachment attention bias were significant,
and for high difficulties with emotion regulation (value = 2.20, M = 0), the slopes of maltreatment on attachment attention bias were significant (see Figure 4).

Using the values obtained from the Johnson-Neyman plots, the influence of childhood history of maltreatment on both negative and attachment attention bias by high and low difficulties with emotion regulation were plotted (see Figure 5 and 6). The nature of the relationship was the same for both attention bias to negative emotional and attachment-related negative emotional stimuli. These plots showed that women who reported higher exposure to childhood maltreatment and greater difficulties with emotion regulation displayed decreased attention to negative and attachment-related emotional stimuli. This is in comparison to women who reported higher exposure to childhood maltreatment and strengthened emotion regulation capacity, who displayed increased attention to negative and attachment-related emotional stimuli.
Figure 3. Johnson-Neyman plot displaying the regions of significance for the interaction effect on negative attention bias. Point estimates are marked by a solid line, and the upper and lower limits of 95% confidence intervals are marked by dotted lines. The latent construct of difficulties with emotion regulation (x-axis) is plotted against slopes of childhood history of maltreatment on negative attention bias (y-axis). When the latent construct of difficulties with emotion regulation is smaller than the value of -1.05 or greater than the value of 1.80, the slopes of maltreatment on negative attention bias are significant as the confidence intervals do not enclose the value of zero. Regions of significance are marked by shadow.
**Figure 4.** Johnson-Neyman plot displaying the regions of significance for the interaction effect on attachment attention bias. Point estimates are marked by a solid line, and the upper and lower limits of 95% confidence intervals are marked by dotted lines. The latent construct of difficulties with emotion regulation (x-axis) is plotted against slopes of childhood history of maltreatment on attachment attention bias (y-axis). When the latent construct of difficulties with emotion regulation is smaller than the value of -1.20 or greater than the value of 2.20, the slopes of maltreatment on attachment attention bias are significant as the confidence intervals do not enclose the value of zero. Regions of significance are marked by shadow.
Figure 5. Level of maternal difficulties with emotion regulation (D-ER) moderating the association between childhood maltreatment score (x-axis) and attention bias to negative emotional words (y-axis).
Figure 6. Level of maternal difficulties with emotion regulation (D-ER) moderating the relationship between childhood maltreatment score (x-axis) and attention bias to attachment-related emotional words (y-axis).

Discussion

Despite a growing body of literature investigating the impact of early childhood trauma on attention bias, little is known about factors that moderate this association. Since attentional bias may contribute to or maintain multiple forms of psychopathology, it is worth examining in a sample particularly at-risk for emotional symptoms, such as postpartum women. The present study examined emotion regulation capacity in postpartum women as a moderator between exposure to childhood maltreatment and
attention to emotional stimuli during an Emotional Stroop task. We found a significant interaction between maternal history of childhood maltreatment and self-reported difficulties with emotion regulation on attention bias to both negative and attachment-related emotional words. Specifically, women with higher levels of childhood trauma and greater difficulties with emotion regulation displayed decreased attention bias towards emotional stimuli (i.e., decreased response latencies to emotional stimuli relative to neutral stimuli), whereas women reporting higher exposure to maltreatment and strengthened emotion regulation capacity displayed increased attention bias towards emotional stimuli (i.e., increased response latencies to emotional stimuli relative to neutral stimuli). This finding provides support for attentional avoidance of threat in postpartum women with childhood history of maltreatment and diminished emotion regulation capacity. Furthermore, this finding suggests that postpartum women with childhood history of maltreatment and improved emotion regulation capacity exhibit attentional allocation towards threat.

Other research examining childhood trauma provides evidence that early life adversity can confer vulnerability for the development of emotional dysfunction, psychopathology, and cognitive processing biases (Fani et al., 2011; Gibb et al., 2009). To our knowledge, this is the first study of self-reported difficulties with emotion regulation as a predictor of attention to negative emotional cues in adults exposed to childhood maltreatment. These results complement other reports that exposure to childhood maltreatment can contribute to attention bias during an Emotional Stroop task (Puetz et al., 2016; Wingenfeld et al., 2011), and maladaptive emotion regulation in adults.
Our finding that emotion regulation ability serves as a moderator of attention bias parallels findings in maltreated children at-risk for depression (Romens & Pollak, 2012). Contrary to our findings, Romens and Pollack (2012) found that children with high levels of maltreatment and high levels of trait rumination (a maladaptive emotion regulation strategy) exhibited increased attention towards sad faces during a dot-probe task. However, these studies are not meant to be equivalent, due to the distinct characteristics of each sample, differences in age and developmental stage, methodology, and the nature of the emotional stimuli presented. Further research is needed to increase our understanding of the long-term effects of emotional regulation on attention bias in a diversity of individuals exposed to maltreatment.

The stress response system exhibits a large amount of individual variation based on early experience, psychological functioning, social relationships, and psychopathology (Boyce & Ellis, 2005; Lupien et al., 2009). The current study found that diminished emotion regulation capacity was associated with decreased attention to negative emotional information in women with greater exposure to child maltreatment. Consistent with the Adaptive Calibration Model (ACM), this suggests that that diminished emotion regulation capacity is a factor that contributes to an unemotional response pattern as a consequence of early adversity. Additionally, the significant finding that improved emotion regulation capacity was associated with increased attention to negative emotional information in women with higher exposure to early maltreatment, suggests that strengthened emotion regulation capacity in this context contributes to a vigilant response.
pattern. Thus, attentional avoidance of emotional stimuli may reflect a larger tendency of maltreated women to dissociate from, instead of become vigilant towards, threat (Del Giudice et al., 2011; Phillips et al., 2013; Tarullo & Gunnar, 2006). In addition to avoidance of threat-related information, the unemotional responsivity pattern is theorized to inhibit social learning and sensitivity to social feedback (Del Giudice et al., 2011). In women displaying an unemotional responsivity pattern, these disruptions are thought to lead to reduced cooperation and parental investment (Del Giudice et al., 2011). Therefore, in terms of the current sample of postpartum women, the unemotional responsivity profile may have negative consequences for parenting behaviour and the mother-infant attachment relationship. Further discussion of the current results in terms of postpartum mental health, maternal attentiveness, and intergenerational processes may help interpret these findings.

Notably, the postpartum era has unique neurobiological and emotional adaptations that are associated with parenthood (Azak & Raeder, 2013; Kim et al., 2010). This period can result in an increased emotional vulnerability for some women, which has significant implications for maternal behaviour (Azak & Raeder, 2013; Olza-Fernández et al., 2014). Difficulties with emotion regulation have been previously linked to mood disorders and other emotional difficulties in postpartum women (Haga et al., 2012). However, after controlling for important individual characteristics, such as postpartum mood and medication use, we were still able to detect altered attention to emotional information in women with childhood history of maltreatment based on their emotion regulation capacity. Thus, the significant interaction between maltreatment experience and emotion
regulation found in this study likely reveals a maladaptive tendency that extends beyond maternal psychopathology.

Research on postpartum affective disorders may help further inform the current findings. Postnatal affective disorders, like generalized anxiety disorder and postpartum depression, have been linked to maladaptive maternal cognitions (Stein et al., 2012). An example of a maladaptive maternal cognition is maternal preoccupation, during which maternal attention is narrowed by intruding negative thoughts and this interferes with parental functioning (Lovejoy, Graczyk, Hare, & Neuman, 2000; Stein et al., 2008). Such maladaptive cognitive mechanisms influence a mother’s attentional resources available for detecting threatening stimuli (Stein et al., 2012; Williams et al., 1996), and this is theorized to negatively impact maternal attentiveness to infant cues (Murray, 2010). Similarly, researchers on the neural processing of negative emotional stimuli in postpartum depression hypothesize that emotional dysregulation hinders the increased sensitivity to threat that is evolutionarily advantageous in helping to protect a newborn (Silverman et al., 2011). Although maternal attentiveness and responsiveness are a crucial component of the mother-infant relationship, maternal attentional disturbances and their clinical implications have not been systematically evaluated (Stein et al., 2012, 2008). The current results suggest that emotional functioning in postpartum women exposed to child maltreatment plays a key role in modulating maternal attentiveness towards negative emotional information. Specifically, that emotional dysregulation impairs an adaptive sensitivity to negative emotional cues that may signal threat.
Although the clinical implications for maternal and infant health have not yet been elucidated, this pinpoints a key target for future investigation.

The current findings also have important implications for the intergenerational transmission of affective regulation and processing. Maternal emotional functioning greatly influences parenting stress and maternal-infant affect regulation (Crugnola et al., 2016). Maternal displays of cognitive, emotional, and behavioural responses to affective stimuli signal information to offspring that influence their perceptions about the early environment (Waters et al., 2015). Prior research has linked maternal attention biases to offspring risk for emotional disorders and offspring development of attention bias (Goodman & Gotlib, 1999; Mogg, Wilson, Hayward, Cunning, & Bradley, 2012; Waters et al., 2015). Recent work exploring the impact of child maltreatment on postpartum depression in South African women, suggests that avoidant affective processing may serve as an intergenerational mechanism through which maternal exposure to maltreatment impacts child development (Choi et al., 2017). Specifically, researchers discovered that mothers with greater exposure to childhood trauma demonstrated decreased selective attention to masked fearful stimuli during an Emotional Stroop task, which in a pathway analysis through postpartum depression was found to negatively impact maternal-infant bonding and child emotional development (Choi et al., 2017). In terms of the current results, this suggests that the attentional avoidance associated with emotional dysregulation in postpartum women with childhood history of maltreatment may transmit risk to their offspring. Presently, we do not know how the current findings impact parenting behaviour and infant development. There is still insufficient
understanding of how maltreatment experiences impact the emotion regulation capacities of adults, especially when they are becoming parents themselves (Kim & Cicchetti, 2010; Morris, Silk, Steinberg, Myers, & Robinson, 2007). Future research is encouraged to explore how maltreatment relates to maternal attentiveness and patterns of stress responsivity across the lifespan.

**Limitations**

The current findings should be considered in light of some limitations. This study used a sample of postpartum women, and due to the unique characteristics of the postnatal period, results are likely not representative of other time points. Although we made every effort to consider relevant covariates, it is possible that other unmeasured variables like maternal sleep quality influenced the current findings (Hunter, Rychnovsky, & Yount, 2009). The study sample included a relatively low risk community sample, which may influence the generalizability of results. Additionally, assessment of child maltreatment was completed via retrospective self-report, which is subject to recall bias and errors in memory (Hardt & Rutter, 2004; Widom et al., 2004). Emotion regulation was also assessed via measures of self-report, which are prone to social-desirability and reporting bias. However, there is currently not a standardized behavioural measure of emotion regulation in adults, and research should continue to explore more naturalistic assessments of emotion regulation (Heiy & Cheavens, 2014; Seeley et al., 2015). This study sought to better understand the direction of attention bias associated with maltreatment through investigation of a potential moderating variable. However, the
mixed results in other attention bias studies may be due differences in stimulus exposure duration, variation in stimulus type and intensity, and the use of mood induction procedures before stimuli presentation in some studies (Gibb et al., 2009; Joormann & Gotlib, 2007). As the Emotional Stroop paradigm used contained word stimuli, and did not vary the emotional value of stimuli, or induce any particular mood before performance was measured, results are not necessarily comparable to other research. Emotional stimuli were selected based on previous recommendations for neutral and emotional words (Williams et al., 1996), with the addition of an attachment-related word category. This attachment-related word category was included as for survivors of maltreatment these stimuli may be more personally salient, signal threat, and activate the neurobiological processes underlying Emotional Stroop performance (Atkinson et al., 2009; Pollak, Cicchetti, & Klorman, 1998; Williams et al., 1996).

**Conclusion**

The present results suggest that emotion regulation is a psychological construct which determines direction of the relationship between exposure to child maltreatment and attention bias. In postpartum women exposed to higher levels of childhood maltreatment, diminished emotion regulation capacity was associated with attentional avoidance of negative emotional stimuli, compared to strengthened emotion regulation capacity which was associated with attentional allocation towards negative emotional stimuli. This study bridges previous research on attention bias and emotion regulation, and suggests that difficulties with emotion regulation and attentional avoidance in
postpartum women may develop as a long-term sequelae of child maltreatment. Although not all individuals exposed to early adversity experience maladaptive outcomes, evidence identifies them at high risk for both emotional and psychophysiological dysfunction (Luke & Banerjee, 2013; Masten & Wright, 1998). Examining the relationships between early trauma and adult regulatory systems can aid in the development of effective prevention and intervention programs. Therapies that focus on emotion regulation and attention training have had success in reducing clinical symptomatology in anxiety disorder, major depressive disorder, and posttraumatic stress disorder (Papageorgiou & Wells, 2000; Wadlinger & Isaacowitz, 2011). Although such therapeutic approaches are not yet widely offered, treatments aimed at promoting effective emotion regulation are an important avenue of exploration in regards to childhood trauma.
Chapter 4: Study 3

General Purpose

In addition to the aforementioned physiological and behavioural reactivity profiles, the ACM also describes the influence of life history strategies and responsivity patterns on processes related to reproduction. An individual’s life history strategy determines the allocation of time and effort towards activities that promote fitness, like mating and parenting (Brüne, 2016; Del Giudice et al., 2011). The ACM suggests that females with the vigilant-withdrawn subtype (III-W) may be predisposed towards overprotective parenting behaviours, with high levels of social support serving as a buffer of this association (Del Giudice, 2014; Del Giudice et al., 2011). Whereas, females with an unemotional phenotype (IV) are hypothesized to display decreased parental investment and insensitivity to social support (Del Giudice et al., 2011). In line with these hypotheses, related research has reported increased levels of social-emotional disturbances, parental distress, and insensitive parenting practices in mothers exposed to childhood trauma (Banyard et al., 2003; Lang, Gartstein, Rodgers, & Lebeck, 2010). Although the ACM does not make any predictions about the implications of each responsivity profile for offspring development, maladaptive parenting practices in mothers exposed to childhood adversity are linked to increased rates of internalizing and externalizing problems in young children (Fredland et al., 2018; Pereira et al., 2018). Furthermore, recent work has proposed an extension of the ACM, in which social-emotional functioning serves as a mechanism that transmits risk in disadvantaged families
(Cabeza de Baca, Wahl, Barnett, Figueredo, & Ellis, 2016). Therefore, in extension of the responsivity profiles described in the ACM, the third objective of this thesis is to examine maternal emotion regulation capacity as a process that underlies preschool children’s behavioural adjustment following maternal exposure to childhood adversity.
Title & Authorship

Title: Maternal adverse childhood experiences (ACEs) and child behavioural problems: the mediating role of emotion regulation

Authors: England-Mason, G., MacMillan, H.L., Atkinson, L., Gonzalez, A.

Conflicts of Interest: None
Abstract

Adverse childhood experiences (ACEs) include experiences of abuse, neglect, and household dysfunction. Extensive research has linked ACEs with a variety of negative health outcomes, with only more recent work beginning to investigate the intergenerational impacts of parental ACEs. Emerging research suggests that maternal ACEs are associated with child behavioural problems. However, little is known about mechanisms that may transmit risk across generations. The aim of the current study was to investigate maternal emotion regulation capacity as a mediator of the association between maternal ACEs and child behaviour outcomes. Participants included 105 women and their 3-year-old children. Mothers completed self-report measures on their experiences of childhood adversity, emotion regulation, and child behaviour problems. Using Mplus software, structural equation models explored whether a latent variable of maternal difficulties with emotion regulation explained the associations between maternal ACEs and child behavioural problems. Maternal difficulties with emotion regulation fully mediated the relations between maternal ACEs and their child’s externalizing (path ab = 0.11, SE = 0.05, t = 1.94, p = 0.05) and internalizing symptoms (path ab = 0.09, SE = 0.04, t = 2.02, p = 0.04). The current results provide support for the role of maternal difficulties with emotion regulation in the intergenerational transmission of risk. As early childhood has significant implications for maternal well-being and child development, these findings are discussed in terms of maternal health, child mental health, and family-based interventions.
Introduction

Adverse childhood experiences (ACEs) are associated with greater risk for behavioural maladjustment, physical conditions, and mental health problems across the lifespan (Bellis et al., 2014; Hughes et al., 2017). Adults exposed to ACEs can exhibit dysfunction in the regulation of emotional responses and experiences (England-Mason, Kimber, et al., 2017; England-Mason, Khoury, Atkinson, Hall, & Gonzalez, 2018), which may translate into difficulties parenting and interacting with their own children (Rutherford et al., 2015). Although limited work has examined the intergenerational implications of parental ACEs, emerging research suggests that maternal ACEs are associated with internalizing and externalizing behavioural problems in children (Fredland, McFarlane, Symes, & Maddoux, 2018; Koverola et al., 2005; Min, Singer, Minnes, Kim, & Short, 2013; Pereira, Ludmer, Gonzalez, & Atkinson, 2018). Additionally, research has examined mediators of the relationship between maternal history of childhood adversity and offspring behavioural problems, primarily focusing on maternal depressive symptomology (Fredland et al., 2018; Koverola et al., 2005; Pereira et al., 2018). However, maternal emotion regulation capacity has never been examined as a potential mechanism that transmits risk to child development following maternal ACEs. This is an important extension, as maternal difficulties with emotion regulation during early childhood pose a particular risk to the foundations of the parent-child relationship and young children’s healthy development (Rutherford et al., 2015). Therefore, the purpose of the current study was to investigate maternal emotion regulation capacity as a
potential mediator of the association between maternal ACEs and young children’s behaviour problems.

**Adverse childhood experiences (ACEs)**

ACEs include exposure to the various forms of abuse and neglect, parental loss (i.e., parental separation or divorce), household mental illness, household substance abuse, incarceration of a family member, and household violence (Anda et al., 2006; Felitti et al., 1998). Across childhood, increasing exposure to ACEs is linked to greater and more persistent emotional and behavioural problems (Rasmussen, Nielsen, Petersen, Christiansen, & Bilenberg, 2014). It is important to note that stressful life experiences during childhood rarely occur in isolation from one another (Dong et al., 2004), and the interaction between two or more ACEs is reported to produce a greater effect than the sum of the individual effects (Hughes et al., 2017). Overall, the general accumulation of ACEs has been previously reported to predict greater emotion dysregulation (Choi & Oh, 2014), as well as psychological and behavioural maladjustment in children and adolescents (Flouri & Mavroveli, 2013; Rasmussen et al., 2014). These difficulties can persist into adulthood, with many large-scale longitudinal studies reporting on how ACEs can become biologically embedded and produce long-term effects on physical and mental health (Bellis et al., 2014; Shonkoff et al., 2012). Only recent work has begun to evaluate the intergenerational implications of parents’ childhood experiences, reporting that maternal ACEs are associated with depressive symptoms, harsher parenting practices, and children’s developmental risk (Sun et al., 2017; Treat, Sheffield Morris, Williamson, Hays-Grudo, & Laurin, 2017; Woods-Jaeger, Cho, Sexton, Slagel, & Goggin, 2018).
Emotion regulation

Emotion regulation is broadly defined as the essential processes through which individuals monitor, evaluate, and modulate emotional experiences and responses (Thompson, 2008). The processes of emotion regulation develop largely within the parent-child relationship and are sensitive to the complex interplay between genetics, neural substrates, and the social environment (Goldsmith et al., 2008; Perry, Calkins, Nelson, Leerkes, & Marcovitch, 2012). Thus, children’s early experiences modify their emotional systems and interact with developmental plasticity in order to influence regulatory behaviours, which have an enduring effect on behaviour and mental health across the lifespan (Goldsmith et al., 2008). Early environments characterized by stress and adversity have a particular impact on a child’s development of adaptive emotion regulation, leading to alterations in the processing of emotional information and difficulties with emotion regulation that can persist into adulthood (Young & Widom, 2014). Resilience research emphasizes the considerable variability in responsivity to stress, such that following childhood adversity there are individual and environmental characteristics that promote positive adaptation (Sexton et al., 2015). Emotion regulation capacity is suggested to be an individual characteristic that likely promotes successful adaptation and development following exposure to childhood adversity (Flouri & Mavroveli, 2013; Kim & Cicchetti, 2010). Specifically, previous research has shown that in adults reporting exposure to childhood trauma, emotion regulation capacity serves as a vulnerability factor for maladaptive social-emotional processing (England-Mason,
Khoury, et al., 2018) and physiological dysregulation of the stress response system (England-Mason, Kimber, et al., 2017). Therefore, the object of the current study is to examine maternal emotion regulation capacity as a mechanism in the intergenerational transmission of risk following childhood adversity.

The intergenerational implications of emotional competency

Deficient maternal emotional control and regulation capacities are associated with parenting difficulties and the intergenerational transmission of emotion dysregulation (Bridgett, Burt, Edwards, & Deater-Deckard, 2015; Crandall et al., 2015). Emotional distress disrupts parent-child interactions and contributes to a range of emotional and behavioural problems in young children, including internalizing and externalizing behaviour problems (Elgar, Mills, McGrath, Waschbusch, & Brownridge, 2007).

Specifically, previous research has shown that maternal emotion regulation processes determine her socialization of her child’s emotion regulation (Morris et al., 2007; Rutherford et al., 2015), and these practices are related to her child’s internalizing and externalizing behaviour problems (Stansbury & Zimmermann, 1999). Maternal emotional disturbances have been found to predict elevated internalizing and externalizing behaviour problems in both clinical and community samples of children and adolescents (Cummings, Keller, & Davies, 2005; Shanahan, Calkins, Keane, Kelleher, & Suffness, 2014). Cumulatively, research suggests that maternal emotional competencies and related parenting behaviours are likely the mechanisms through which young children incur risk for adjustment problems (Rutherford et al., 2015; Stansbury & Zimmermann,
Overall, these findings highlight the theoretical associations between maternal emotion regulation capacity and child behaviour, suggesting that maternal difficulties with emotion regulation may transmit risk to child behavioural development following maternal experiences of childhood adversity.

### Emotion regulation as a potential mediator of the intergenerational impact of ACEs

The purpose of current study is to examine maternal emotion regulation capacity as a potential mechanism through which maternal ACEs transmit risk to their child’s development. Previous research supports this model, as maternal experiences of childhood trauma are associated with a wide spectrum of behavioural difficulties, including internalizing and externalizing behaviour problems, in the next generation (Lang, Gartstein, Rodgers, & Lebeck, 2010; Min et al., 2013; Pereira et al., 2018). Previous mediators of the relationship between maternal reports of childhood trauma and child behaviour problems have been identified; including maternal psychosocial distress, depressive symptoms, and adult attachment (Min et al., 2013; Pereira et al., 2018). These are noteworthy findings, as the processes of emotion regulation are closely linked with, but distinct from, both psychopathology (Sheppes et al., 2015) and attachment theory (Waters et al., 2010). In extension of this work, the current study seeks to investigate maternal emotional regulation competency as a mediating variable in the association between maternal ACEs and child behaviour problems.
The present study

Often the literature examining emotion regulation diverges based on use of a particular conceptual model, considering either the process model (Gross & John, 2003) or the emotional competency model (Gratz & Roemer, 2004). Several studies have provided evidence that these models assess distinct, but related, processes of emotion regulation (Bardeen & Fergus, 2014; Ehring & Quack, 2010). Such that, the process model assesses individual use of specific emotion regulation strategies (i.e., cognitive reappraisal, expressive suppression) and the emotional competency model measures general capabilities that allow individuals to modify their emotional reactions (Bardeen & Fergus, 2014). In line with previous recommendations to consider the multi-dimensional processes of emotion regulation (Aldao & Dixon-Gordon, 2014; Tull & Aldao, 2015) and previous work investigating difficulties in emotion regulation in mothers exposed to childhood trauma (England-Mason, Kimber, et al., 2017; England-Mason, Khoury, et al., 2018), this project will adopt a comprehensive approach and assess maternal emotion regulation across the two models. To our knowledge, the role of emotion regulation capacity in the intergenerational association between maternal exposure to childhood adversity and offspring behavioural development has never been explored. Therefore, the aim of the current study is to use structural equation modeling to explore a latent construct of maternal difficulties with emotion regulation as a potential mediator of the association between maternal ACEs and child behaviour problems. Findings from this work have important implications for maternal and child mental health, as well as the potential to inform preventative interventions for families exposed to ACEs.
Materials & Methods

Participants

Participants included a community sample of 105 mothers who were recruited from the maternity ward at St. Joseph’s Healthcare Hamilton, Ontario. Study inclusion criteria included: a) mothers to be age 18-years or older at the time they gave birth; b) mothers to have given birth at full-term to a healthy infant; c) mothers to be able to access their infants at the time of the home visits; and d) mothers to have the ability to read, write, and speak English. Exclusion criteria included any characteristics that would not permit participants to complete the research measures, for example cases of severe disability and language barriers. Written, informed consent was obtained for all study participants. The study protocol was approved by the McMaster Research Ethics Board and the St. Joseph’s Healthcare Research Ethics Board.

Procedure

Data collection was conducted from May 2014 until December 2015 by a research team at the Offord Centre for Child Studies. When children were approaching their third birthday, mothers were contacted by phone and their participation in the study was requested. Families who consented to participate were visited in their homes by two research assistants for 2-hours when their children were approximately 38-months of age. During the home visit, mothers completed self-report questionnaires on their experiences of childhood adversity, emotion regulation, mood, and their children’s behaviour.
problems. At the time of the home visit, mothers were aged 22 to 45 years (M = 34.4, SD = 4.7) and their children (51.4% female) were between 38 to 44 months of age (M = 39 months, SD = 1.4 months). Participants were primarily university educated (54.2%) and currently in spousal relationships (75.7%). The median maternal and partner salary range was between $35,000 - $69,999 Canadian dollars. In the current sample, 14.0% of women reported belonging to a visible minority.

Measures

*Adverse Childhood Experiences (ACEs)*. Maternal exposure to childhood adversity was assessed using the Childhood Trauma Questionnaire (CTQ; Bernstein & Fink, 1998) and the National Comorbidity Survey- Revised: Childhood Questionnaire (NCS-R: Section 37; Kessler & Merikangas, 2004). The CTQ is a 28-item self-report questionnaire which evaluates types of childhood abuse (emotional, physical, sexual) and neglect (emotional, physical) using a 5-point Likert scale (*I = never; 5 = very often*). The CTQ has demonstrated strong psychometric properties in both community and clinical population, and in relation to other retrospective maltreatment assessment tools (Scher et al., 2001). In the present sample, the five abuse and neglect subscales from the CTQ had high internal consistency estimates (0.86 ≥ Cronbach’s *a* ≤ 0.93). Participants also completed a section of the revised version of the National Comorbidity Survey, which includes a core battery of questions about events of psychological distress during childhood that were designed to reduce non-response bias and efficiently assess
retrospective reports of childhood experiences (Kessler & Merikangas, 2004). Specifically, participants completed a subset of questions from Section 37 of the NCS-R. This section included two items that assessed childhood exposure to parental loss (i.e., divorce, separation) and 12 items that assessed parental mental illness (i.e., anxiety, depression) (Kessler & Merikangas, 2004).

Previous research has used the ACE Study Questionnaire as a template to construct a summary measure of adverse childhood events (Hostinar, Lachman, Mroczek, Seeman, & Miller, 2015; Racine, Madigan, Plamondon, McDonald, & Tough, 2018). In line with this approach, the current study created a summary measure of childhood adversity which assessed childhood exposure to the three subtypes abuse, two subtypes of neglect, parental loss, and parental mental illness. A score of “1” was assigned to each experience based on low-to-moderate cut-offs from the CTQ (Bernstein & Fink, 1998) and positive screens from the NCS-R (Kessler & Merikangas, 2004), leading to an overall possible maximum score of 7 on this summary scale. Following the recommended scoring of the ACEs index from previously published analyses (Anda et al., 2006; Bellis et al., 2014), scores ≥ 4 were reduced to a single category for experiencing 4 or more childhood stressors, such that the final range for the summary index was 0-4. Given the consistently reported dose-response effect of ACEs, creating a cumulative index is the best practice (Bellis et al., 2015, 2014).

**Emotion Regulation Questionnaire (ERQ).** The ERQ (Gross & John, 2003) is a self-report measure which comprises 10 items that evaluate individual differences in the
habitual use of two emotion regulation strategies, expressive suppression and cognitive reappraisal. Participants answered items for each of these strategies on a seven-point Likert scale (1 = strongly disagree; 7 = strongly agree). A sample item from the expressive suppression scale is, “I control my emotions by not expressing them”, and an example from the cognitive reappraisal scale is, “I control my emotions by changing the way I think about the situation I’m in”. Items were grouped together into composite variables for each trait strategy. The ERQ has been found to possess strong internal consistency for both trait expressive suppression (Cronbach’s $\alpha = 0.76$) and trait cognitive reappraisal (Cronbach’s $\alpha = 0.82$) (Wiltink et al., 2011). In the current study, the ERQ was also found to have acceptable internal consistency for both expressive suppression (Cronbach’s $\alpha = 0.70$) and cognitive reappraisal (Cronbach’s $\alpha = 0.78$).

**Difficulties in Emotion Regulation Scale (DERS).** The DERS (Gratz & Roemer, 2004) is a 36-item self-report questionnaire that assesses an individual’s general difficulties at regulating their emotions across six dimensions. These dimensions include: non-acceptance of negative emotions, difficulties engaging in goal-directed behaviours, difficulties controlling impulsive behaviours, limited access to effective emotion regulation strategies, lack of emotional awareness, and lack of emotional clarity. Participants rated items on a five-point Likert scale (1 = almost never; 5 = almost always). Total scores from each of these six dimensions of emotion dysregulation were calculated and used in statistical analyses. The DERS has been found to have strong overall internal consistency and adequate internal consistency for each of the six
subscales (Gratz & Roemer, 2004). In the current sample, the DERS possessed high overall internal consistency (Cronbach’s $\alpha = 0.88$) and acceptable internal consistency for each subscale ($0.70 \geq$ Cronbach’s $\alpha \leq 0.81$).

**Child Behaviour Checklist (CBCL).** Mothers completed the CBCL (Achenbach & Ruffle, 2000) for preschool children aged 1.5-5, a checklist which consists of 99 items describing common childhood problems. Parents are asked to rate each problem on a three-point rating scale ($0 = \text{not at all}, 1 = \text{sometimes}, 2 = \text{yes}$). Items represent two symptom subscales: internalizing and externalizing problems. The internalizing scales includes four subscales: emotionally reactive, anxious depressed, withdrawn, and somatic complaints. The externalizing scale includes two subscales: attention problems and aggressive behaviours. Previous research has indicated that this inventory demonstrates good reliability and validity (Achenbach & Ruffle, 2000). In the present study, this checklist also demonstrated acceptable internal consistency for the internalizing subscale (Cronbach’s $\alpha = 0.70$) and externalizing subscale (Cronbach’s $\alpha = 0.93$).

**Center for Epidemiological Studies Depression Scale (CES-D).** The CESD (Radloff, 1977) is a 20-item self-report measure for the general population that assesses depressive symptomology over the past week. The CES-D has shown high internal consistency and test-rest reliability, as well as adequate validity with other self-report measures and clinical ratings of depression (Radloff, 1977). In the present sample this measure also had acceptable internal consistency (Cronbach’s $\alpha= 0.77$).
**Covariates.** A review of the literature identified a few potential confounding variables. Previous research has reported that adults exposed to ACEs are at an increased risk for lower educational attainment, problems in interpersonal relationships, and mental health problems (Bellis et al., 2014; Shonkoff et al., 2012). Therefore, in addition to the maternal mood measure, a background information questionnaire collected information pertaining to sociodemographic factors (i.e., education level, marital status, household income) and other relevant sample characteristics (i.e., age, child sex). These potential confounding variables were investigated in the mediation models as covariates.

**Analytic Strategy**

**Missing data and preliminary analyses.** Among the 105 participants in this sample, 9.5% (n = 10) were missing data on one or more items. This was due to the incomplete or missing answers on the self-report questionnaires. Otherwise, all the other participants (n = 95) had complete data on the other variables of interest (e.g., socioeconomic status, history of childhood adversity, emotion regulation subscale scores, child behaviour outcomes, etc.). Based on Little’s Missing Completely at Random (MCAR) test, $x^2 (183) = 93.72, p > 0.05$, these data were deemed appropriate for imputation. Data were imputed for all missing items using imputation techniques in SPSS 24.0 (IBM Corp., 2016). Based on previously recommended practices, expectation maximization methods were used to impute 100 data files and then one imputed dataset
was randomly selected for descriptive statistics, bivariate correlations, and structural equation modeling (Bodner, 2008). Following imputation, descriptive statistics were completed in order to check for normality. The independent and dependent variables, maternal ACE score and child behaviour problems, did not violate the assumptions of normality. However, maternal CES-D score and some of the emotion regulation subscales were skewed. Therefore, preliminary analyses used nonparametric tests to investigate the correlations between the variables of interest.

**Measurement model of the latent variable.** A latent variable mediation model was selected because it has an improved ability to assess complex processes and reduces parameter estimation (Kline, 2011). The measurement model of the latent variable was evaluated using the recommended indices of model fit: the Chi-square test ($\chi^2$), Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), and Tucker Lewis Index (TLI). In order for a model to be accepted as consistent with the data, the $\chi^2$ test should be non-significant, the RMSEA value should be below 0.06, and the CFI and TLI values should be above 0.95 (Hu & Bentler, 1998; Kline, 2011).

**Latent variable mediated structural equation model (SEM).** The primary analyses were to determine if maternal emotion regulation capacity served as a mechanism underlying the relationship between maternal exposure to childhood adversity and children’s behaviour problems at age 3. Mediation analyses were conducted using a latent construct of maternal difficulties with emotion regulation in version 7.4 of Mplus
software (Muthén & Muthén, 1998-2011). A latent variable mediated structural equation model with the bootstrapping method was selected in order to test the significance of the total and indirect effects. The bootstrapping method is recommended as preferable to the casual steps method (Baron & Kenny, 1986) for testing indirect effects (MacKinnon & Fairchild, 2010), as the bootstrapping method does not require a significant main effect from the independent variable to the dependent variable and is recommended for mediation models with small to moderate sample sizes (Shrout & Bolger, 2002). The bootstrapping method involves drawing a large number of resamples with replacement from the observed dataset (5,000 in the present study), then estimating the indirect effects for each bootstrap sample, and then these estimates are used to construct bias-corrected confidence intervals in order provide the greatest statistical power and to correct for skew (MacKinnon & Fairchild, 2010). Thus, an indirect effect is determined to be statistically significant when the bias-corrected confidence interval does not include a zero (MacKinnon & Fairchild, 2010; Preacher & Hayes, 2004). Separate latent variable mediation models were run in order to examine the impact of maternal ACEs and difficulties with emotion regulation on child internalizing and externalizing behaviour problems. For both of these models, regression analyses initially examined the impact of covariates on child behaviour problems. Then regression analyses examined the total, direct, and indirect effects, whilst controlling for relevant covariates.
Results

Maternal ACEs

The prevalence of maternal experiences of childhood adversity by experience subtype and ACE index score are reported in Table 1. In terms of the derived ACE index score, 31.8% of the sample did not report exposure to any ACEs, 35.5% reported exposure to a single ACE, 17.8% reported exposure to two ACEs, 7.5% reported exposure to 3 ACEs, and 7.5% reported exposure to ≥ 4 ACEs. Overall, the current ACE index revealed similar estimates to international prevalence statistics, with prior research showing that 46.6-47.1% of respondents report exposure to a singular ACE and 8.3-12.3% of respondents report exposure to ≥ 4 ACEs (Bellis et al., 2015, 2014).

Measurement model of the latent variable

Bivariate correlations amongst the emotion regulation subscale were evaluated. In the current study, there were numerous significant Spearman correlations between the different measures of emotion regulation (|0.24| ≥ r ≤ |0.48|, p < 0.05), which were accounted for in the measurement model. This is consistent with previous research that has incorporated subscales from the ERQ and the DERS, which reported small-to-moderate correlations between the subscales (|0.17| ≥ r ≤ |0.50|, p < 0.05) (Bardeen & Fergus, 2014; Ehring & Quack, 2010). The first-order measurement model of the latent variable, difficulties with emotion regulation, included 8 factors: the 6 subscale scores from the DERS, the trait suppression subscale score from the ERQ, and the reverse-
scored trait reappraisal subscale score from the ERQ. In the measurement model, all 8 factors significantly loaded onto the latent construct and had standardized beta coefficients with values ≥ 0.4, which is consistent with the recommended practices for confirmatory factor analysis (Brown, 2015). The measurement model of the latent construct of difficulties with emotion regulation showed good model fit: $x^2 = 14.88$, df = 14, $p > 0.05$; RMSEA = 0.03; CFI = 0.99; TLI = 0.99.

**Bivariate correlations**

Descriptive statistics and bivariate correlations between the main study variables are reported in Table 2. There were numerous significant Spearman correlations between the main variables, with maternal ACE score significantly correlated with CES-D score ($r_s = 0.28$, $p < 0.05$), child internalizing problems ($r_s = 0.24$, $p < 0.05$), and child externalizing problems ($r_s = 0.24$, $p < 0.05$). The latent variable of maternal difficulties with emotion regulation was significantly correlated with CES-D score ($r_s = 0.69$, $p < 0.05$), but not with maternal ACE score or either child internalizing or externalizing behaviour problems.
Table 1

Prevalence of adverse childhood experiences (ACEs)

<table>
<thead>
<tr>
<th></th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Childhood Neglect</strong></td>
<td></td>
</tr>
<tr>
<td>Physical neglect</td>
<td>4.7</td>
</tr>
<tr>
<td>Emotional neglect</td>
<td>3.7</td>
</tr>
<tr>
<td><strong>Childhood Abuse</strong></td>
<td></td>
</tr>
<tr>
<td>Physical abuse</td>
<td>10.3</td>
</tr>
<tr>
<td>Emotional abuse</td>
<td>15.0</td>
</tr>
<tr>
<td>Sexual abuse</td>
<td>15.0</td>
</tr>
<tr>
<td>Divorce or separation</td>
<td>26.7</td>
</tr>
<tr>
<td><strong>Household Mental Illness</strong></td>
<td></td>
</tr>
<tr>
<td>Maternal depression</td>
<td>36.6</td>
</tr>
<tr>
<td>Maternal anxiety</td>
<td>27.3</td>
</tr>
<tr>
<td>Paternal depression</td>
<td>13.0</td>
</tr>
<tr>
<td>Paternal anxiety</td>
<td>14.9</td>
</tr>
<tr>
<td>Any household mental illness</td>
<td>57.1</td>
</tr>
<tr>
<td><strong>ACE Score</strong></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>31.8</td>
</tr>
<tr>
<td>1</td>
<td>35.5</td>
</tr>
<tr>
<td>2</td>
<td>17.8</td>
</tr>
<tr>
<td>3</td>
<td>7.5</td>
</tr>
<tr>
<td>4+</td>
<td>7.5</td>
</tr>
</tbody>
</table>
Table 2

Non-parametric correlations and descriptives amongst study variables

<table>
<thead>
<tr>
<th>Main study variables</th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ACE score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.23 (1.19)</td>
</tr>
<tr>
<td>2. CES-D score</td>
<td></td>
<td>.28*</td>
<td></td>
<td></td>
<td>8.96 (8.76)</td>
</tr>
<tr>
<td>3. Difficulties with emotion regulation</td>
<td>.17</td>
<td>.69*</td>
<td></td>
<td></td>
<td>0.24 (1.03)</td>
</tr>
<tr>
<td>4. Child internalizing problems</td>
<td>.24*</td>
<td>.35*</td>
<td>.18</td>
<td></td>
<td>51.02 (9.22)</td>
</tr>
<tr>
<td>5. Child externalizing problems</td>
<td>.25*</td>
<td>.38*</td>
<td>.17</td>
<td>.59*</td>
<td>50.77 (8.32)</td>
</tr>
</tbody>
</table>

* p < 0.05 level.

Mediation Analyses

Model 1. The first mediation model examined the relationship between maternal ACEs and child externalizing behaviour problems in the presence of the latent variable, maternal difficulties with emotion regulation (Figure 1). In the initial examination of potential covariates, only maternal CES-D score ($\beta = 0.38, t = 4.49, p < 0.01$) emerged as a significant predictor of child externalizing problems at age 3, none of the other covariates (i.e., maternal age, marital status, education level, household income, number of other children in the household, visible minority status, child gender) significantly predicted the variance in child externalizing problems. However, in the mediation model maternal CES-D score ($\beta = 0.04, t = 0.13, p = 0.98$) dropped from significance as a covariate, hence it was removed as a covariate from the final model. Nevertheless, the relationship between the latent variable and CES-D scored was still examined, and in
final model the latent variable of difficulties with emotion regulation was significantly correlated with CES-D score ($r = 0.74$, $p < 0.01$). In the final mediation model, there was a significant total effect of maternal ACEs on child externalizing problems (path $c = 0.30$, $SE = 0.09$, $t = 3.23$, $p < 0.01$). Maternal ACEs were related to greater difficulties with emotion regulation (path $a = 0.21$, $SE = 0.09$, $t = 2.28$, $p = 0.02$) and more difficulties with emotion regulation were related to greater child externalizing problems at age 3 (path $b = 0.49$, $SE = 0.10$, $t = 4.81$, $p < 0.01$). There was a significant indirect effect, thus maternal difficulties with emotion regulation emerged as a significant mediator (path $ab = 0.11$, $CI_{95} = 0.03, 0.26$, $SE = 0.05$, $t = 1.94$, $p = 0.05$). The direct effect of maternal ACEs on child externalizing problems was non-significant (path $c' = 0.08$, $SE = 0.12$, $t = 0.73$, $p = 0.47$), indicating ‘full’ or ‘indirect-only’ mediation (Baron & Kenny, 1986; Zhao, Lynch, & Chen, 2010).

**Model 2.** The second mediation model showed similar results for the relationship between maternal ACEs and child internalizing behaviour problems in the presence of the latent variable, maternal difficulties with emotion regulation (Figure 2). In the initial examination of potential covariates, only maternal CES-D score ($\beta = 0.29$, $t = 3.23$, $p < 0.01$) emerged as a significant predictor of child internalizing problems at age 3, none of the other covariates (i.e., maternal age, marital status, education level, household income, number of other children in the household, visible minority status, child gender) significantly predicted the variance in child internalizing problems. However, in the mediation model maternal CES-D score ($\beta = -0.12$, $t = -0.33$, $p = 0.74$) dropped from
significance as a covariate, hence it was removed as a covariate from the final model. Nevertheless, the relationship between the latent variable and CES-D score was still examined, and in final model the latent variable of difficulties with emotion regulation was significantly correlated with CES-D score ($r = 0.74$, $p < 0.01$). In the final mediation model, there was a significant total effect of maternal ACEs on child externalizing problems ($\text{path } c = 0.24$, $SE = 0.09$, $t = 2.60$, $p = 0.01$). Maternal ACEs were related to greater difficulties with emotion regulation ($\text{path } a = 0.21$, $SE = 0.10$, $t = 2.20$, $p = 0.03$) and more difficulties with emotion regulation were related to greater child internalizing problems at age 3 ($\text{path } b = 0.42$, $SE = 0.10$, $t = 4.27$, $p < 0.01$). There was a significant indirect effect, thus maternal difficulties with emotion regulation emerged as a significant mediator ($\text{path } ab = 0.09$, $CI_{95} = 0.02, 0.21$, $SE = 0.04$, $t = 2.02$, $p = 0.04$). The direct effect of maternal ACEs on child internalizing problems was non-significant ($\text{path } c' = 0.06$, $SE = 0.11$, $t = 0.53$, $p = 0.59$), indicating ‘full’ or ‘indirect-only’ mediation (Baron & Kenny, 1986; Zhao et al., 2010).
Figure 1. Full model and results for the mediation model in which maternal ACEs and latent difficulties with emotion regulation were examined in relation to child externalizing behaviours.

Note. The oval represents the latent variable and the rectangles represent the observed variables. Standardized beta coefficients and standard errors in brackets are reported; *p ≤ 0.05.
Figure 2. Full model and results for the mediation model in which maternal ACEs and latent difficulties with emotion regulation were examined in relation to child internalizing behaviours.

Note. The oval represents the latent variable and the rectangles represent the observed variables. Standardized beta coefficients and standard errors in brackets are reported; *p < 0.05.
Discussion

The aim of the current study was to examine maternal emotion regulation capacity as a potential mediator of the relationship between maternal ACEs and their preschool child’s behaviour problems. In line with our hypotheses and the results of previous studies, maternal history of childhood adversity was indirectly associated with greater internalizing and externalizing problems in young children (Min et al., 2013; Pereira et al., 2018). Additionally, we found a significant total effect of maternal ACEs on child behavioural problems, which is consistent with a recently published cohort study that reported associations between a mother’s ACEs and her child’s internalizing and externalizing problems at 3-years of age (Fredland et al., 2018). Furthermore, as expected based on the results of prior reviews and meta-analyses (Aldao & Dixon-Gordon, 2014; Sheppes et al., 2015), this study also found a strong association between emotion regulation and depressive symptomology. Given the significance of emotional health for family well-being during early childhood, these findings are discussed in terms of parental psychobiological health, child behavioural development, and therapeutic approaches for families exposed to ACEs.

Previous studies have examined emotion regulation as a mediator of the associations between ACEs and various measures of psychological functioning, including behaviour problems during childhood (Choi & Oh, 2014), behavioural maladjustment during adolescence (Flouri & Mavroveli, 2013), and risk for psychopathology during adulthood (Jennissen, Holl, Mai, Wolff, & Barnow, 2016). However, this is the first investigation of emotion regulation in regards to parental ACEs and offspring behaviour.
outcomes. This represents a gap in the research, as it has been proposed that the nature and function of emotion regulation processes during parenthood are distinct from other contexts and periods of life (Rutherford et al., 2015). Parents are tasked with having to simultaneously model and teach effective emotion regulation, often during their child’s emotional distress and dysregulation (Morris et al., 2007). This is especially challenging for parents with limited skills to manage their own emotional reactivity, and has clinical implications for their child’s regulatory functioning (Rutherford et al., 2015). Previous research has identified that maternal emotion dysregulation is associated with parenting difficulties and the intergenerational transmission of emotional problems (Bridgett et al., 2015; Crandall et al., 2015). Furthermore, difficulties with emotion regulation underlie multiple forms of psychopathology, especially in parents exposed to childhood trauma, and thus may serve as a mechanism in the intergenerational transmission of childhood developmental risk (Bridgett et al., 2015; Fenerci, Chu, & DePrince, 2016). Considering the implications of emotion regulation skills in parents exposed to ACEs is important, as prior work has linked maternal exposure to childhood trauma and current difficulties with emotion regulation to altered attention to social-emotional information (England-Mason, Khoury, et al., 2018) and dysregulation of the hypothalamic-pituitary-adrenal axis (England-Mason, Kimber, et al., 2017). Thus, the current results add to the growing body of literature examining childhood adversity and emotion regulation, suggesting that ACEs have an enduring influence on maternal psychobiological regulation.

During the childrearing years, mothers exposed to childhood adversity report more physical and mental health problems (McDonnell & Valentino, 2016; Sun et al.,
2017). Maternal ACEs are also associated with harsher parenting attitudes, negative parental attributions, and controlling parenting practices (Treat et al., 2017; Woods-Jaeger et al., 2018). However, little is known about the pathways that may mediate associations between maternal ACEs and childhood development outcomes (McDonnell & Valentino, 2016). Previous research shows that maternal ACEs have direct links to poorer child social-emotional health outcomes, including maladaptive social-emotional symptoms (e.g., difficulties calming down, trouble feeding, crying) (McDonnell & Valentino, 2016), and behavioural maladjustment (Fredland et al., 2018). Additionally, studies have examined how maternal ACEs may indirectly impact child functioning. Previous investigations report that maternal psychological distress, social support, parenting, depressive symptoms, and avoidant attachment serve as partial mediators of the relationship between maternal history of childhood trauma and child behaviour outcomes (Koverola et al., 2005; Min et al., 2013; Pereira et al., 2018). Although prior research has begun to partially elucidate the casual processes underlying this relationship, the results of the present study indicate that emotion regulation capacity is a pivotal factor in the association between maternal ACEs and child behavioural problems. Therefore, the current results augment the existing evidence linking maternal ACEs with emotional dysfunction and indicate that difficulties with emotion regulation plays a mechanistic role in the intergenerational transmission of risk following ACEs.

Examining the intergenerational impact of parental ACEs and emotional dysregulation on child behavioural development is an important intersection, as internalizing problems that are present during early childhood are predictive of later
adjustment difficulties in older childhood (Shanahan et al., 2014; Sterba et al., 2007). Similarly, externalizing problems that are present during toddlerhood and the preschool years are robust predictors of more severe behavioural problems during the elementary school years (Campbell et al., 2000). Notably, internalizing and externalizing problems during childhood have a high rate of comorbidity (Achenbach, Ivanova, Rescorla, Turner, & Althoff, 2016). However, these problems typically have a divergent impact, as internalizing problems are prognostic of later depressive symptomology (Sterba et al., 2007) and externalizing problems incur greater risk for substance use and criminality (Miettunen et al., 2014). The results of the present investigation indicated that maternal ACEs and difficulties with emotion regulation were predictive of both child internalizing and externalizing problems. Previous parent-training interventions have examined the effectiveness of emotion-regulation focused programs for improving parental emotional competencies and ameliorating child internalizing and externalizing problems (Havighurst et al., 2013; Wilson, Havighurst, & Harley, 2012). However, the efficacy of these approaches have never been examined in parents reporting exposure to childhood adversity. This suggests that future research should evaluate the effect of interventions targeting emotion regulation in the context of maternal ACEs, as these interventions may act protectively in terms of child behavioural trajectories and family mental health.

**Limitations**

There are several limitations which are important to consider when interpreting the current findings. Firstly, participants included a fairly low-risk community sample,
which may influence the generalizability of results. Additionally, it is notable that adult retrospective self-reports of ACEs are prone to recall bias and fallibility of memory, although research notes that false positives are rare (Hardt & Rutter, 2004; Widom et al., 2004). Previous research has used the ACE Study Questionnaire as a template to construct a summary measure of adverse childhood events (Hostinar, Lachman, et al., 2015; Racine et al., 2018). In line with this approach, the current study created a summary measure of childhood adversity using outcomes from two established questionnaires that assess experiences of childhood trauma, the CTQ (Bernstein & Fink, 1998) and the NCS-R (Kessler & Merikangas, 2004). Unfortunately, this summary measure is limited as the current study did not collect information on the other three commonly studied ACEs: parental substance abuse, parental incarceration, and household violence. Although the present study only assessed 7 of the 10 typically-defined ACEs (Anda et al., 2006; Felitti et al., 1998), the prevalence of exposure to a singular ACE (35.5%) and to ≥ 4 ACES (7.5%), were similar to international estimates for exposure to a singular ACE (46.6-47.1%) and ≥ 4 ACES (8.3-12.3%) (Bellis et al., 2015, 2014). Maternal emotion regulation capacity and child behaviour problems were also assessed via measures of self-report, which are subject to social-desirability and reporting bias. To our knowledge, there is not currently a standardized behavioural measure of emotion regulation in adults (Seeley et al., 2015). Thus, future research is encouraged to evaluate ecologically-valid measures of emotion regulation and to examine the nature of the reported associations using external-reports and observational measures of child behaviour.
Conclusion

The present findings indicate that latent difficulties with emotion regulation is a psychological mechanism underlying the association between maternal ACEs and child behaviour problems. In mothers of 3-year-old children, maternal emotion regulation capacity indirectly influenced the effect of maternal ACEs on both child internalizing and externalizing problems. Such that, mothers reporting more ACEs and greater difficulties with emotion regulation had children with more internalizing and externalizing problems. Consistent with the hypothesized model, maternal difficulties with emotion regulation served as a mediating variable in the intergenerational transmission of risk following ACEs. Examining potential mediating variables of previously identified associations between a parent’s early experiences and their children’s development can help pinpoint targets for prevention and intervention programs. The current results suggest that therapeutic approaches aimed at improving maternal emotion regulation capacity are an important avenue of investigation for families exposed to ACEs.
Chapter 5: General Discussion

Summary

Collectively, these three studies demonstrated that in mothers reporting greater exposure to childhood adversity: 1) emotion regulation capacity influenced postpartum HPA axis activity, such that greater exposure to childhood trauma and more difficulties with emotion regulation were related to decreased cortisol reactivity; 2) emotion regulation capacity influenced postpartum attention bias, such that greater exposure to childhood trauma and more difficulties with emotion regulation were related to attentional avoidance of negative and attachment-related emotional stimuli; and 3) emotion regulation capacity influenced child behaviour outcomes at 38-months, such that greater maternal exposure to childhood adversity and more difficulties with emotion regulation were related to more internalizing and externalizing problems in young children.

5.1. Further Discussion of the Adaptive Calibration Model (ACM)

a) Study 1: Physiological Reactivity

The physiological responsivity patterns proposed in the ACM have received some empirical attention and evaluation in child and adolescent samples. In a preliminary study, finite mixture modeling provided initial support for the differentiation between the four patterns of stress responsivity based on family stress levels during middle childhood.
(Del Giudice, Hinnant, Ellis, & El-Sheikh, 2012). Broadly consistent with the responsivity patterns described in the ACM (Del Giudice et al., 2011), this study showed that ‘sensitive’ children displayed higher parasympathetic nervous system (PNS) and sympathetic nervous system (SNS) reactivity, ‘buffered’ children displayed high PNS activity and low SNS reactivity, ‘vigilant’ children displayed moderate PNS levels and higher SNS reactivity, and ‘unemotional’ children displayed lower PNS activity and SNS reactivity (Del Giudice, Hinnant, Ellis, & El-Sheikh, 2012). Relatedly, a recent examination of the four-pattern taxonomy of the ACM in adolescent males revealed general consistency, with some deviations, of the latent responsivity profiles across the PNS, SNS, and adrenocortical system based on antecedent measures of familial and ecological stress (Ellis, Oldehinkel, & Nederhof, 2017).

To the best of my knowledge, this thesis is the first application and examination of the vigilant and unemotional phenotypes in women with a history of childhood trauma. In extension of the previous investigations, the current findings provide preliminary support for the existence of the ‘unemotional’ HPA axis responsivity profile (e.g., decreased cortisol reactivity) in women reporting greater exposure to childhood adversity and higher difficulties with emotion regulation. However, given that exposure to childhood adversity was unrelated to cortisol reactivity at lower difficulties with emotion regulation, it is difficult to interpret the potential implications of these results for the other responsivity profiles. Future research is encouraged to investigate the associations between emotion regulation and the sensitive, buffered, and vigilant phenotypes in mothers exposed to a range of childhood experiences.
b) Study 2: Social-Emotional Processing

In regards to the adaptive function of social-emotional processing patterns, it is of importance to further discuss the hypothesized sex differences in regards to the vigilant (III) and unemotional (IV) responsivity profiles. In the ACM, the vigilant phenotype is associated with divergent distributions of behaviours, including aggression/externalizing problems (III-A) and withdrawn/internalizing problems (III-W). The vigilant-agonistic subtype (III-A) is hypothesized to develop more often in males, and the vigilant-withdrawn subtype (III-W) is thought to be female-biased (Del Giudice, 2014; Del Giudice et al., 2011). These are notable distinctions, as within the context of attention to emotional stimuli, the vigilant-withdrawn subtype is consistent with the increased attention towards threatening emotional cues often reported in depression (Hankin, Gibb, Abela, & Flory, 2010; Hommer et al., 2014) and anxiety disorders (Bar-Haim et al., 2007; Cisler & Koster, 2010). There are also sexually dimorphic behavioural patterns associated with the unemotional phenotype, with males predicted to display more antisocial behaviors, and females expected to experience greater difficulties in emotional understanding and social relationships (Del Giudice, 2014; Del Giudice et al., 2011). These hypothesized deficits in ‘unemotional’ females are perhaps similar to previous work reporting associations between difficulties with attachment relationships and attentional avoidance of emotional stimuli in adults exposed to childhood maltreatment (Davis et al., 2014).

In the present study, the finding that postpartum women reporting greater childhood trauma and strengthened emotion regulation capacity displayed attentional
allocation towards negative emotional stimuli appears to support the theory that an internal appraisal mechanism shifts attention towards threatening cues (Bradley et al., 1998; Wilson & MacLeod, 2003). Whereas, the finding that postpartum women reporting greater childhood trauma and more difficulties with emotion regulation exhibited attentional avoidance of negative emotional stimuli supports the defensive exclusion hypothesis, the notion that the attachment system protects an individual from re-experiencing distress by turning their attention away from negative emotional information (Bowlby, 1982; Dykas & Cassidy, 2011; Mikulincer et al., 2003). Overall, it is challenging to draw inferences given the significant intersections between emotion regulation, attachment relationships, and psychopathology (Beauchaine, 2015; Nigg, 2017; Waters et al., 2010). Additionally, given that the interaction effects of these models were examined using regions of significance, further interpretation of these results in regards to the sensitive and buffered phenotypes is currently indeterminable. In order to better understand the impact of childhood adversity on these interconnected processes, future studies are encouraged to investigate the complex interplay between emotion regulation, the attachment system, emotional disorders, and affective processing responsivity patterns in mothers exposed to a variety of childhood contexts.

c) Study 3: Reproduction-Related Processes

The ACM theorizes that an individual’s life history strategy influences reproductive processes and parental care (Brüne, 2016; Del Giudice et al., 2011). Animal research has illustrated how levels of maternal care can alter the development of brain
morphology and stress physiology in offspring, and although low quality maternal care may have seemingly maladaptive impacts, these changes appear to enhance learning and memory under conditions of stress (Meaney, 2001; Meaney & Szyf, 2005). These neural and physiological alterations also mediate the effects of the early caregiving environment on the offspring’s own reproductive strategies and parenting behaviours (Cameron et al., 2008; Cameron et al., 2005). In line with this evidence, the ACM postulates that life history strategies modulate individual differences in stress responsivity, which influences parenting behaviour (Brüne, 2016; Del Giudice et al., 2011). Developing in a safe environment, or a moderately stressful environment which is buffered by secure attachments to primary caregivers, results in infrequent and low-intensity activation of the stress response system (Gunnar, Brodersen, Nachzias, et al., 1996). The ACM hypothesizes that this type of early context shifts an individual’s life history strategies towards higher levels of somatic effort and parental investment (Del Giudice et al., 2011). Conversely, developing in dangerous and highly stressful childhood environment, which is not buffered by attachment security, likely results in maladaptive stress reactivity (Gunnar, Brodersen, Nachmias, et al., 1996; Raby, Labella, Martin, Carlson, & Roisman, 2017). In the ACM, this type of traumatic childhood context and corresponding dysregulation are associated with reduced parental investment (Del Giudice et al., 2011).

An application of the ACM to the study of disadvantaged families suggested that socioemotional functioning serves to mediate the impact of early adversity on health disparities (Cabeza de Baca et al., 2016). Building off of this theoretical extension, and given that the two prior studies of this thesis provided preliminary evidence that emotion
regulation capacity may differentiate between vigilant and unemotional phenotypes in mothers reporting greater exposure to childhood trauma, the third study sought to examine the influence of maternal difficulties with emotion regulation on the intergenerational transmission of risk. Consistent with the overlapping theoretical frameworks of life history theory and stress-health relationships (Cabeza de Baca et al., 2016; Del Giudice, 2014; Del Giudice et al., 2011), mothers reporting greater exposure to childhood adversity and more difficulties with emotion regulation had preschool children with more adjustment problems. Although this investigation was unable to examine the role of other theoretically relevant factors (i.e., HPA axis reactivity, social-emotional processing, and parenting behaviours) on this relationship, this suggests that emotion regulation capacity, and potentially responsivity profile, in mothers exposed to childhood adversity plays a mechanistic role in the intergenerational transmission of risk. However, the impact of the other ACM phenotypes on offspring behavioural development remains unclear, and future investigations should seek to examine the intergenerational and bidirectional relationships between these interconnected variables.

5.2. Future Considerations and Implications

In line with the theoretical foundations of the ACM, this dissertation provides preliminary support for the existence of ‘vigilant’ and ‘unemotional’ responsivity patterns in mothers reporting greater exposure to childhood adversity across physiological reactivity, attention to social-emotional information, and parenting-related processes. However, the ACM acknowledges that there are potential switch points across
development, which are mediated by hormonal and plasticity-based mechanisms, during which an individual’s responsivity profile may change based on interactions between genes and the environment (Del Giudice et al., 2011). A notable limitation of the current dissertation is the exclusive examination of mothers, and future research is encouraged to examine the presently reported associations in fathers exposed to childhood trauma, as well as in individuals exposed to early adversity during other transitional periods (e.g., puberty, menopause, etc.). Additionally, research acknowledges that future examinations of the ACM need to integrate the role of specific genes and epigenetic mechanisms, which likely differentially impact males and females, in the intergenerational transmission of stress responsivity patterns (Champagne, 2010; Meaney, 2010).

In addition to the theoretical significance of the present findings, the collective results also have implications for prevention and intervention research. Exposure to trauma during childhood is noted as a risk factor for multiple forms of psychopathology, including depression, anxiety, and posttraumatic stress disorder (Cicchetti & Toth, 1995; Collishaw et al., 2007; Molnar, Buka, & Kessler, 2001; Raymond et al., 2017; Sperry & Widom, 2013). Previous research has examined both HPA-axis activity (Ehlert, 2013; Raymond et al., 2017; Tarullo & Gunnar, 2006) and social-emotional information processing biases (McLaughlin & Lambert, 2017) as central mechanisms linking childhood adversity to the development of various psychopathologies. Generally, exposure to trauma alters the affective and neurobiological systems that serve to identify potential threats and modulate emotional responses to those threats (McLaughlin & Lambert, 2017; McLaughlin et al., 2015). Although these alterations may serve adaptive
purposes in dangerous childhood contexts, they likely have enduring influences on emotional learning, emotional reactivity, and emotion regulation (McLaughlin & Lambert, 2017). The present findings indicated that emotion regulation capacity in mothers reporting greater exposure to childhood trauma moderated between both HPA axis and social-emotional attention responsivity profiles, and suggests that intervention approaches aimed at improving emotion regulation in this context may help promote resilience across the neuroendocrine system and selective attention network. Recent evidence suggests that for individuals who experience difficulty regulating both their emotional reactivity and attentional processing in threat-related contexts, the impact of psychosocial challenges and stressors on HPA axis responsivity may be more pronounced (Lenaert, Barry, Schruers, Vervliet, & Hermans, 2016). This is an important consideration, as the relations between emotion regulation, attentional control, and cortisol reactivity are likely multi-directional and more complex than portrayed in the present findings. Thus, further investigation of populations at-risk for and displaying multidimensional dysregulation may facilitate more targeted intervention approaches, as individuals experiencing both social-emotional processing difficulties and cortisol dysregulation and may also benefit from training programs that are known to enhance attentional control (Chambers et al., 2007).

The present findings also indicated that maternal emotion regulation capacity mediated the intergenerational associations between maternal exposure to childhood adversity and preschool children’s behavioural problems. These results suggest that preventative programs targeting emotion regulation in families exposed to childhood
adversity may act protectively in regards to child risk for internalizing and externalizing psychopathology. Although existing, evidence-based parenting interventions report significant improvements in parenting quality and child behaviour problems, results show that they often have limited effectiveness for families with psychopathology and emotion dysregulation (Barlow, Bergman, Kornør, Wei, & Bennett, 2016; Lundahl, Risser, & Lovejoy, 2006; Reyno & McGrath, 2006). Research reports that parents experiencing difficulties with emotion regulation are currently underserved by existing parenting interventions, and suggests that explicitly targeting emotion regulation may improve overall treatment effectiveness for these families (Gaviţa, David, Bujoreanu, Tiba, & Ionuţiu, 2012; Maliken & Katz, 2013).

Dialectical Behaviour Therapy (DBT; Linehan, 1993) is a form of cognitive behavioural therapy that directly seeks to improve emotion regulation skills. DBT was originally developed for parasuicidal women with borderline personality disorder; however, since its original inception, DBT has been empirically evaluated for survivors of sexual abuse, eating disorders, substance abuse issues, and mood disorders (Crowell, Beauchaine, & Linehan, 2009; Decker & Naugle, 2008; Robins & Chapman, 2004). In addition to fostering strategic affect regulation, DBT can also teach parents other valuable skills, such as distress tolerance (e.g., helping parents to accept circumstances that they cannot change), mindfulness skills (e.g., helping parents to stay present and reorient attention as needed), and how to identify and label emotions (Ben-Porath, 2010). Consistent with the latent variable presented in this thesis describing ‘difficulties in emotion regulation’, this training addresses both specific emotion regulation strategies
and more global abilities such as emotional awareness and acceptance. This comprehensive skillset is theorized to benefit a wide variety of parents who may struggle to varying degrees with the strong emotions involved in childrearing or when their child’s behavioural problems are source of emotional arousal (Ben-Porath, 2010). Although DBT is not a parenting intervention, research suggests that DBT improves parenting in mothers with clinically-significant levels of emotion dysregulation and could be modified to specifically target parenting-related behaviours (Zalewski, Stepp, Whalen, & Scott, 2015). A recent group case study evaluated the utility of a DBT skills group for mothers with severe emotion dysregulation and diagnosis of at least one Axis I disorder, and following treatment mothers reported lower parenting stress, decreased use of controlling parenting practices, and improvements in their abilities to validate and respond sensitively to their children’s intense emotions (Martin, Roos, Zalewski, & Cummins, 2017). Thus, additional research is warranted in order to examine the impact of DBT, and other emotion-focused interventions, on emotional health and parenting in mothers experiencing varying degrees of difficulties with emotion regulation. Collectively, the results of this dissertation suggest that therapies aimed at improving emotion regulation skills may act protectively in women reporting greater exposure to childhood adversity and current difficulties with emotion regulation across physiological responsivity, social-emotional processing, and intergenerational processes.
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