Executive Function and Trajectories of Emotion Dysregulation in Children with Behavior Problems

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Executive Function and Trajectories of Emotion Dysregulation in Children with Behavior Problems

A Thesis Presented

By

ALLISON BINDER

Submitted to the Graduate School of the University of Massachusetts Amherst in partial fulfillment of the requirements for the degree of

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Executive Function and Trajectories of Emotion Dysregulation in Children with Behavior Problems

A Thesis Presented

By

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ABSTRACT

EXECUTIVE FUNCTION AND TRAJECTORIES OF EMOTION DYSREGULATION IN CHILDREN WITH BEHAVIOR PROBLEMS

MAY 2017

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The preschool years are a critical time for the development of emotion regulation, which is vital for children’s intellectual and social growth. Children with behavior problems are at particular risk of developing poor regulatory skills. Understanding factors underlying emotion dysregulation in children with behavior problems is therefore important for fostering children’s emotional development. Although theory and research suggest executive function may be important in this regard, its role among children at-risk for emotion dysregulation remains unclear. The goal of the current study was to examine whether executive function predicted trajectories of emotion dysregulation from age 3 to age 5 among children with behavior problems. This study focused on 199 3-year-old children with behavior problems who took part in a larger longitudinal study. Results revealed that response inhibition and working memory were not predictive of later emotion dysregulation. However, children who exhibited worse delay of gratification at ages 3 and 4 had greater symptoms of externalizing emotion dysregulation at age 5. In addition, children who made more omission errors on a test of attentional control at ages
3 and 4 exhibited greater externalizing emotion dysregulation at age 5. Gender differences emerged on two measures of delay of gratification and one measure of attentional control. Results suggest that specific facets of executive function may play an important role in difficulties with emotion dysregulation across the preschool years and that this pattern may differ across boys and girls.

*Keywords:* Emotion-dysregulation, executive function, preschool-aged children, behavior problems
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CHAPTER 1

EXECUTIVE FUNCTION AND EMOTION DYSREGULATION

1.1 Introduction

The development of emotion regulation represents a key developmental task during early childhood. Although evidence of regulatory behaviors can be observed as early as infancy (Kopp, 1982; Stifter, 2002), the preschool years mark a time of rapid improvement in emotion regulation. During this period, children acquire new capacities to monitor and control their emotional expression. These advances in emotion regulatory skills form an important foundation for preschoolers’ emotional and social functioning (Denham et al., 2012). Not all children, however, follow adaptive trajectories of emotional development. Children who suffer from emotion dysregulation exhibit poor or maladaptive control over their emotional expression and are at particular risk for psychopathology (Seymour et al., 2012). Therefore, it is important to understand factors that contribute to emotion dysregulation. The literature (Barkley, 1997; Zelazo & Carlson, 2012) suggests that executive function plays a key role in the development of emotion regulation. Thus, deficits in executive function may be an important determinant of emotion dysregulation. However, much of the literature linking executive function with emotion regulation (or linking poor executive function with emotion dysregulation) is cross-sectional. Examining whether poor early executive function predicts subsequent developmental trajectories of emotion dysregulation can provide stronger evidence than cross-sectional research that impaired executive function is an important determinant of emotion dysregulation. It is especially critical to understand the role of executive function in emotion dysregulation within populations of younger children because early
problems with executive function and emotion regulation may be markers of psychopathology later in life. Children with behavior problems, in particular, are often at risk for both deficits in executive function and emotion dysregulation, underscoring the need for additional empirical research using this subset of the population.

### 1.2 Defining Emotion Regulation and Emotion Dysregulation

Emotion regulation is defined as “the extrinsic and intrinsic processes responsible for monitoring, evaluating, and modifying emotional reactions…to accomplish one’s goals” (Thompson, 1994). This is considered a crucial component of a child’s overall emotional competence, which undergoes substantial growth during the preschool years (Denham et al., 2012). Regulation can occur at a number of different points as an emotional response unfolds (Gross, 2002). It may occur before the response is generated, as is often the case for children who encounter something unpleasant; they are quick to cover their eyes or ears in an attempt to avoid a potentially unpleasant emotional experience (Sala, Pons, & Molina, 2014). At other times, regulation occurs after the emotional response has already been initiated, a strategy commonly referred to as “response modulation.” Children illustrate this strategy through the use of relaxing and/or self-soothing behaviors, such as deep breaths, thumb-sucking, venting (Premo & Kiel, 2014).

Emotion regulation is rarely a linear process, and multiple strategies may be deployed during any given context; it is inherently fluid, dynamic, and ongoing, involving changes in behavioral, experiential, and physiological domains. The literature distinguishes emotion regulation from closely related processes like emotional reactivity, with the latter pertaining to the intensity of an emotional response rather than the control
of that intensity (Carthy, Horesh, Apter, & Gross, 2010). However, this distinction is often difficult to capture in younger children because children have poorer insight into their emotional control processes. Instead, researchers frequently depend on caregivers to identify characteristics and patterns of emotion, many of which are in the earliest stages of development (Eisenberg et al., 1995). If emotion regulation is effective, it should minimize emotional reactivity, so much of the child literature relies on emotional reactivity as a proxy for emotion regulation (Ursache, Blair, Stifter, & Voegtline, 2012).

Ideally, regulatory practices are adaptive; they support one’s goals and promote healthy functioning. When regulatory practices become maladaptive and inflexible, this results in emotion dysregulation, which refers to “poor control over affective experience and expression” (Cole, Michel, & Teti, 1994). Emotion dysregulation does not imply an absence of regulation; rather, it points to a presence of maladaptive regulatory strategies that may be more or less impairing within a certain context (Gratz & Roemer, 2004; Herndon, Bailey, Shewark, Denham, & Bassett, 2013). Research suggests that differences in caregiving, temperament, and brain development may activate these maladaptive patterns (Cole, Dennis, Smith-Simon, & Cohen, 2009; Eisenberg et al., 2010; Monk, 2008; Skuse, Morris, & Lawrence, 2003). Unfortunately, when children adopt ineffective regulatory strategies early on, there is great potential for these patterns to become characteristic and longstanding (Denham et al., 2003).

1.3 Emotion Regulation and Early Development

Emotion regulation undergoes rapid growth as a child enters the preschool years. Beginning early in the lifespan, subcortical structures, including the amygdala and ventral striatum, are actively involved in the processing of emotional information (Swartz,
As the child reaches preschool age, the prefrontal cortex undergoes significant development and assumes greater influence over emotion processes (Diamond & Goldman-Rakic, 1985). More specifically, as the prefrontal cortex becomes more adept at modulating and amplifying emotional processes, new inhibitory and self-regulatory functions emerge (Banks, Eddy, Angstadt, Nathan, & Phan, 2007; Monk, 2008; Pitskel, Bolling, Kaiser, Crowley, & Pelphrey, 2011).

These rapid changes in neurodevelopment underlie remarkable gains in social, emotional, and cognitive functioning. Prior to these changes, children have a limited ability to regulate their own emotions. Children depend on their caregivers to respond to signals of emotional distress, messages that children usually relay through crying. With the advent of these new changes, children can integrate new autonomous behaviors to manage emotions (Cole et al., 1994; Gross & Thompson, 2007). Much of this autonomy depends on enhanced inhibitory control, attention, and language skills, which play key roles in the development of emotion regulation. For example, upon entry into preschool, children initially struggle with tasks that require inhibiting their emotions. However, by the end of preschool, the ability to suppress a maladaptive response for a less dominant but more adaptive response shows remarkable improvement (Kochanska, Murray, & Harlan, 2000). An expanding attentional network accompanies these changes; children at this stage demonstrate increased proficiency in their ability to focus on a specific target, ignore irrelevant information, and divert attention away from negative stimuli when a situation demands (Garon, Bryson, & Smith, 2008; Thompson, 1994). In addition to these changes, enhanced language skills cultivate greater emotional understanding and
provide a new means of expression. Children have access to a catalogue of verbal strategies to relay distress, further minimizing the utility of crying (Cole et al., 1994).

Most children demonstrate dramatic improvements in emotion regulation during the preschool years and can adaptively respond to increased social demands. However, not all children follow the same developmental trajectory, with some children demonstrating significant struggle in regulating their emotions. These early signs of difficulty are particularly problematic, because poor regulatory patterns may become characteristic and less malleable later in life (Denham et al., 2003; Ekas, Lickenbrock, & Braungart-Rieker, 2013). In fact, studies have consistently linked early difficulties in emotion regulation with a number of poor outcomes (Calkins, 1994; Cole et al., 1994; Denham et al., 2012; Eisenberg et al., 1995; Halligan et al., 2012; Kim, Nordling, Yoon, Boldt, & Kochanska, 2013; Levine, Kaplan, & David, 2013). More specifically, children who are emotionally dysregulated demonstrate lower cognitive and academic function (Bell & Wolfe, 2004), are rated by parents and teachers as less socially competent (Denham, 1986), and are at risk for developing a variety of psychiatric disorders (Melnick & Hinshaw, 2000).

1.4 The Role of Executive Function in Emotion Dysregulation

Impaired executive function may be an important determinant of later emotion dysregulation, especially during the course of early development. Executive function is the umbrella term used to describe higher-order cognitive processes that are responsible for regulatory control over thought and action (Zelazo & Müller, 2002). Executive function has been conceptualized as having multiple subcomponents, including response inhibition, working memory, flexible attention, and delay of gratification. These
processes work in concert, but each also exhibits a unique function and is associated with a specific region of the prefrontal cortex (Zelazo & Cunningham, 2007). Additionally, these domains follow divergent growth trajectories; some domains develop faster than others, and these differences are particularly salient in early childhood (Barkley, 2010).

In recent decades, researchers have posited that successful emotion regulation likely depends on adequate executive function capabilities. In fact, in some cases, emotion regulation has been defined by the executive processes that comprise it. Gottman and Katz (1989) proposed that successful emotion regulation requires one to “inhibit inappropriate behavior” (i.e., response inhibition) and “refocus attention” (i.e., attentional control). Similarly, others have reported that impairments of executive function likely lead to secondary problems with emotion regulation (Barkley, 1997; Sjöwall, Roth, Lindqvist, & Thorell, 2013). Despite theoretical support, the causal link between executive function and emotion regulation in children has received little empirical attention because much of the literature is cross-sectional. Longitudinal research is especially valuable for teasing apart the direction of this relation, so temporal precedence can be established. Of the few longitudinal studies, some evidence suggests that early executive function may equip children with better emotion regulation skills as they get older. For example, poorer performance on early composites of executive function has been linked to lower observer ratings of modulated emotional expression at 6-month (Ferrier, Bassett, & Denham, 2014) and 1-year follow-ups (Blankson et al., 2013; Kochanska et al., 2000). Similarly, worse performance on an attentional control task assessed at 18 months was linked to more negative emotionality observed during a 1-year follow-up (Gaertner, Spinrad, & Eisenberg, 2008). Additionally, lower parent
ratings of attentional control in preschool children were associated with poorer emotional knowledge in first grade (Schultz, Izard, Ackerman, & Youngstrom, 2001). Parent-reports also revealed that worse attentional and effortful control at 18 months was associated with more separation distress (Eisenberg et al., 2010) and negative emotionality (Gaertner et al., 2008) measured 1 year later. Taken together, these studies suggest that early problems with executive function may place children at risk for emotion dysregulation. It is also important to note that although this paper focuses on the role of executive function in emotion dysregulation, there is also evidence that early emotion dysregulation places children at risk for later executive function deficits (Hill-Soderlund & Braungart-Rieker, 2008; Ursache et al., 2012).

In sum, there is a small body of longitudinal research that provides some support for a causal link between executive function and emotion regulation, though even longitudinal studies are still correlational and therefore do not provide definitive causal evidence. However, these studies have generally focused on just single measures of executive function. It is not yet clear whether different aspects of executive function might be differentially predictive of later emotion dysregulation. Closer examination into the distinct domains of executive functions may provide greater clarity regarding possible links to emotion dysregulation. I will review here the literature on the relation between different domains of executive function and emotion regulation/dysregulation. Note that although the focus of this paper is on emotion dysregulation, I will also include studies that focus on the link between executive function and emotion regulation abilities, because poor emotion regulation skills are likely to be directly linked with emotion dysregulation.
1.4.1 Response inhibition. Response inhibition involves the suppression of a dominant response according to some simple rule (Garon et al., 2008). Although evidence of response inhibition can be seen as early as infancy (Kopp, 1982), children demonstrate the most significant improvements during the preschool years, followed by more modest and slow-moving gains throughout later childhood (Pauli-Pott & Becker, 2011). Response inhibition is thought to play a crucial role in the successful development of emotion regulation (Butler & Gross, 2009; Joormann & Gotlib, 2010; Tang & Schmeichel, 2014). Prior to the preschool years, children’s displays of emotion are often impulsive, automatic, and unfiltered. As response inhibition grows, children exercise greater restraint in responding to emotional events. They learn to suppress reactive behaviors, and their responses become more deliberate, appropriate, and adaptive within a given context (Garon et al., 2008).

The link between response inhibition and emotion regulation has been well-documented in populations of older children and adults (Gyurak et al., 2009; Hoeksma, Oosterlaan, & Schipper, 2004; Joormann & Gotlib, 2010; Schmeichel & Tang, 2015; Sjöwall et al., 2013; Tang & Schmeichel, 2014; Walcott & Landau, 2004). However, to my knowledge, only a handful of studies have explored this link in younger children. Two studies document a link between children’s response inhibition and emotion regulation. In one study by Carlson and Wang (2007), response inhibition was measured through a modified version of Simon Says, which required preschoolers to follow simple commands from one “good” puppet, while ignoring commands from one “bad” puppet. The investigators found that children who made fewer errors on this task expressed less negativity after receiving a disappointing gift and were rated by their parents more
positively on a scale of emotion regulation. Replicating these results using a similar disappointing gift paradigm, Hudson and Jacques (2014) found inhibitory control to be a significant predictor of a composite measure of emotion regulation in 5- to 7-year-olds, controlling for other relevant variables. Other studies yielded more mixed findings. More specifically, Jones, Rothbart, and Posner (2003) measured preschoolers’ response inhibition through a game of Simon Says, recording reaction times and tracking errors for each child. The investigators found no association between overall accuracy on this task and parent-reports of emotional expression. However, a positive association between reaction times following error trials, which is thought to be an indicator of a child’s ability to detect errors, and parent ratings of fear approached significance. The authors attributed this finding to similar underlying neural circuitry responsible for both fear and error detection. Likewise, no significant links were found in another study of preschoolers’ performance on response inhibition tasks and their negative expression following receipt of a disappointing gift (Kieras, Tobin, Graziano, & Rothbart, 2005). However, when comparing each child’s responses to both the “undesirable” gift and subsequent “desirable” gift, the investigators noted that children with stronger inhibitory skills showed smaller differences in positive affect, suggesting that these children exerted greater regulatory control over their emotional expression. Similarly, another study revealed no significant association between response inhibition and parent-reported emotion regulation in preschool-aged children (Leerkes, Paradise, O’Brien, Calkins, & Lange, 2008). Although the same team of investigators reported a significant link between response inhibition and emotion regulation in a later study, their index of response inhibition included a simple measure of working memory as well (Blankson et
al., 2013). In sum, the existing literature provides mixed support for a link between response inhibition and emotion regulation in young children. Additional longitudinal research is needed to resolve these inconsistencies remaining in a body of literature that is predominantly based on cross-sectional design.

1.4.2 Attention control. The ability to focus, sustain, and flexibly shift attention is fundamental to most executive processes. During the first few months of life, children rely on more primitive attention systems (i.e., alerting and orienting systems) while adjusting to ongoing changes in the environment. As early as 6 months, children begin to display some degree of control over gaze and shifting behaviors (Morales, Mundy, Crowson, Neal, & Delgado, 2005; Thompson, 1994). By the second year, their executive attention system establishes predominance over their alerting and orienting systems, allowing them to navigate their environments with greater autonomy and flexibility (Graziano, Calkins, & Keane, 2011; Jones et al., 2003; Lewis, 2005; Rueda, Posner, & Rothbart, 2005; Simonds, Kieras, Rueda, & Rothbart, 2007). Upon entering preschool, this autonomy translates into greater sustained attention and focused attention, both of which are invaluable tools for conflict resolution and emotion regulation (Garon et al., 2008). Equipped with greater attentional control, children can respond to their emotions by diverting their attention away from unwelcomed stimuli and redirecting their focus to more positive elements in the environment (Fernandez-Duque, Baird, & Posner, 2000; Gross & Thompson, 2007; Johnson, 2009; Joormann & Gotlib, 2010; Morales, 2005; Schmeichel & Tang, 2015).

Our understanding of the link between attentional control and emotion regulation emerges from multiple sources. In adult populations, researchers have highlighted the
impact of attentional control for successful disengagement from emotional events. When people come across threatening stimuli in the atmosphere, they rely on flexible movement of attention to shift their focus to something more positive, thereby averting an emotional response from escalating. In contrast, adults with poorer attentional control struggle to disengage, which may, in turn, amplify the threat and lead to heightened anxiety (Cisler & Koster, 2010; Derryberry & Reed, 2002; Johnson, 2009; Schmeichel & Tang, 2015). Likewise, the coping literature suggests that effective coping strategies, like distraction, often depend on adequate attentional control; in some cases, children may focus their attention on reward instead of frustration, and in other cases, they may shift their attention away from threat and toward safety and reassurance (Bamford & Lagattuta, 2011; Brown, Oudekerk, Szwedo, & Allen, 2013; Derryberry & Rothbart, 1988; Derryberry, Reed, & Pilkenton-Taylor, 2003; Sayfan & Lagattuta, 2009). This is supported by empirical research that indicates that children who use coping strategies grounded in attentional control are better able to regulate negative emotions (Rice, Levine, & Pizarro, 2007) and exhibit fewer externalizing problems and greater cooperation (Gilliom, Shaw, Beck, Schonberg, & Lukon, 2002). Despite these findings, only a handful of studies have directly looked at the link between attentional control and emotion regulation in preschoolers. More specifically, toddlers and preschoolers who performed better on laboratory measures of focused attention and attentional shifting, used more help-seeking and less avoidant emotion regulation strategies (Graziano et al., 2011), and displayed less negative emotionality (Belsky, Friedman, & Hsieh, 2001). Laboratory measures of attentional control converge with informant reports: preschoolers who received higher ratings of attentional control were described by parents
(Liebermann, Giesbrecht, & Müller, 2007), teachers (Herndon et al., 2013), and trained observers (Gaertner et al., 2008) as exhibiting less negative emotionality and less emotion dysregulation. Although the relation between attentional control and emotion regulation has been consistent across studies, the present literature would benefit from additional longitudinal research to examine how attentional control relates to emotion regulation trajectories.

1.4.3 Working memory. Working memory refers to the ability to continuously store, update, and manipulate information in the mind so it remains readily available for active use (Baddeley, 2003). First emerging in infancy, the ability to hold representations in the mind and the ability to effectively update those representations follow similar growth trajectories and develop well into adolescence (Best & Miller, 2010). The preschool years may be particularly noteworthy in the development of working memory due to marked linear increases in both storing and updating capabilities (Best & Miller, 2010; Garon et al., 2008). These gains are thought to have great impact on a child’s ability to effectively regulate his or her emotions (Barkley, 2010). More specifically, in order to effectively regulate emotions or bring oneself to a certain emotional state, working memory can be an important tool for recalling and holding in memory effective emotion regulation strategies.

Considerable research in older children and adult populations has linked better working memory with less negative affect (Pe, Raaes, & Kuppens, 2013), increased modulation of emotional expression (Schmeichel, Volokhov, & Demaree, 2008), fewer problems with emotion regulation (Sjöwall et al., 2013), and more frequent use of putatively adaptive strategies such as reappraisal to regulate emotions (Opitz, Lee, Gross,
However, to my knowledge, only three studies have specifically looked at working memory performance and emotion regulation in samples of younger children. Wang and Saudino (2013) explored this link along with potential genetic and environmental factors in a sample of 3-year-old same-sex twin pairs. The investigators found that better working memory performance, as determined by a composite of working memory measures that involved both maintenance and updating capabilities, was significantly associated with more observed emotion regulation. In another study, Leerkes et al. (2008) found a significant relation between forward digit span and parent-reports of both emotion regulation and lability in 3- to 5-year-old children. In contrast, Liebermann et al. (2007) looked at backward digit span in that same age group and found no significant relations between scores on digit span and parent-reports of emotion regulation. These conflicting findings may reflect the multidimensional nature (i.e., storing, updating, and manipulating) of working memory and suggest that the strength of the association between working memory and emotion regulation may differ for different aspects of working memory. However, the limited number of studies on working memory and emotion regulation in preschoolers makes it difficult to determine the reason for contradictory findings.

### 1.4.4 Delay of gratification

The presence of reward exerts a unique influence on executive functions and decision-making capacities. Delay of gratification refers to one’s ability to forgo an immediate reward in favor of a future reward of a greater value. Prior to the preschool years, children struggle to exercise this skill, and there is little expectation for them to behave otherwise (Kalpidou, Power, Cherry, & Gottfried, 2004). When children begin preschool, they suddenly face new sets of rules that are no longer
tailored to any one child but now account for the interests of multiple children. Children are expected to impose self-restraint given their newly acquired autonomy to make decisions: they must wait their turn. Most children struggle initially with this skill, but by the end of preschool they demonstrate substantial improvement. Unlike other executive functions, delays of gratification tasks contain a motivational component, so they may inherently tax emotions. In that sense, delay of gratification may depend on emotion regulation abilities (Zelazo & Cunningham, 2007). However, delay of gratification tasks additionally require the child to exercise inhibitory control, and this control likely plays an important role in children’s ability to inhibit maladaptive responses to emotional contexts, including in contexts that do not involve reward.

Despite the intuitive link between delay of gratification and emotion regulation, only a small number of studies have directly investigated this relation in preschoolers. This is particularly surprising when considering the influence of Mischel and colleagues’ (1988) renowned “marshmallow experiments” completed decades earlier: 4- and 5-year-olds who were more successful in their refrain from eating a marshmallow, exhibited substantially better emotion regulatory skills 10 years later in adolescence (Mischel, Shoda, & Peake, 1988). Indeed, little work has been done to specifically explore this link within the preschool years. In Carlson and Wang’s (2007) investigation of response inhibition in preschoolers, children were presented with a wrapped gift in one task and a forbidden toy in another task and were instructed to wait for the experimenter’s permission to unwrap the gift and play with the toy. Better performance on each measure was associated with earning higher scores on a composite of emotion regulation, including less observed negative expressivity when receiving a disappointing gift. Using
similar measures, Liebermann et al. (2007) found that children who performed better on a present delay task were more likely to express positive behaviors upon receiving an undesirable gift on a separate task. This association has received additional support from temperament research linking better delay of gratification with less mother-reported separation distress (Eisenberg et al., 2010). In contrast, Kalpidou et al. (2004) found an inverse association between delay performance and emotion regulation in preschoolers. Three-year-olds who performed worse on a delay task appeared most emotionally comfortable. In contrast, this relation was in fact positive in their sample of 5-year-olds; children who performed worse on the delay of gratification task appeared more emotionally uncomfortable during the task. This finding suggests that delay of gratification may be linked to emotion regulation in both 3- and 5-year-olds, but the direction of this relation may differ depending on the age. However, Hongwanishkul, Happaney, Lee, and Zelazo (2005) did not find any significant links between delay performance and parent reports of positive or negative affect among preschool-aged children. In light of these mixed findings, additional longitudinal research may clarify how delay of gratification impacts the development of emotion regulation as children age.

1.4.5 Broad measures of executive function. Although executive function is generally understood to be a multidimensional construct, a number of studies have examined how broad measures of executive function are associated with emotion regulation. In preschoolers, better measured executive function was related to increased emotional understanding (Hughes, Dunn, & White, 1998), and better effortful control was linked to greater positive affect on laboratory tasks (Kochanska et al., 2000;
Lunkenheimer, Olson, Hollenstein, Sameroff, & Winter, 2011). Furthermore, older children who scored higher on parent-reports of effortful control received higher ratings of emotion regulation from teachers (Batum & Yagmurlu, 2007) and lower ratings of anger from their peers (Liew, Eisenberg, & Reiser, 2004). Although these studies do not contribute to our knowledge of how specific executive functions relate to emotion regulation, the results from these studies add further support for a strong link between executive function and emotion regulation.

1.5 Children with Behavior Problems

Deficits in emotion regulation have been consistently documented in young children with behavior problems. These children typically struggle to identify and cope with negative emotions, respond poorly to disappointing situations, and express more outward anger than their same-age peers. Children with behavior problems are at much greater risk for acquiring future psychopathology, and emotion dysregulation may serve a mediating role between this initial risk and later development of severe psychological disorders (Seymour et al., 2011). Therefore, detecting factors that contribute to deficits in emotion regulation may be particularly critical for younger, at-risk populations. Indeed, considerable research indicates that early deficits in executive functions may underlie symptoms of impulsivity and poor self-control experienced by children with behavior problems, which, in turn, result in difficulties in regulating anger and negative emotions (Dolan & Lennox, 2013; Kim et al., 2013; Yang et al., 2011). Surprisingly, most of the research highlighting the role of early executive dysfunction in predicting later problems with emotion regulation has been restricted to community samples, thus neglecting the children who are most at risk for future emotion dysregulation and
concurrent psychopathology (Barkley, 1997; Castellanos, Sonuga-Barke, Milham & Tannock, 2006; Sjöwall et al., 2013; Solanto et al., 2001; Fraire & Ollendick, 2013; Steinberg & Drabick, 2015).

1.6 Gender, Emotion Dysregulation, and Executive Function

There is some evidence to suggest that gender differences may play a role in our understanding of the relation between emotion dysregulation and executive function (Kochanska et al., 2000). In a sample of older children, neurocognitive problems, including poorer performance on response inhibition and working memory tasks, were associated with affective problems in girls but not in boys (van Deurzen et al., 2012). This relation is less clear in populations of younger children. However, several studies have noted that girls undergo more rapid developmental maturation, which may explain why girls exhibit better inhibitory skills, better focused-attention, better language skills, and more pro-social behavior in the preschool years (Gaertner et al., 2008; Keenan & Shaw, 1997; Matthews, Marulis, & Williford, 2014; Raaijmakers et al., 2008; Zahn-Waxler, Shirtcliff & Marceau, 2008). Moreover, multiple studies that included measures of executive function and emotion dysregulation have reported converging findings that girls exhibited better executive function and less emotion dysregulation (Hudson & Jacques, 2014; Lunkenheimer et al., 2011; Wang & Saudino, 2013). Fewer studies, however, have specifically examined if the relation between executive function and emotion dysregulation differs in boys and girls. Herndon et al. found that emotion dysregulation was linked to less engaged behavior in the classroom for preschool-aged boys, whereas there was no significant link for girls. In contrast, Silk et al., (2006) found that reward anticipation during a delay task in 4- to 7-year-olds was strongly linked to
fewer internalizing problems for girls and more weakly related for boys. Carlson and Wang (2007) similarly found that inhibitory control, including delay performance, was more strongly related in preschool-aged girls but more weakly related in boys. Interestingly, some authors have posited that these advanced cognitive skills may actually be detrimental to girls. Armored with more effective inhibitory control, girls are often regarded as less disruptive than boys. Consequently, problems faced by girls are often internalized and are at an increased risk of going unnoticed by parents and teachers (Keenan & Shaw, 2007; Zahn-Waxler et al., 2008). Taken together, our understanding of the link between executive function and emotion dysregulation may additionally benefit from exploring potential moderators.

1.7 The Current Study

The purpose of the current study was to address a significant gap in the literature by longitudinally examining the relation between early executive function and later emotion dysregulation in preschoolers with behavior problems. Due to the multidimensional nature of executive function, distinct domains may be differentially stronger or weaker predictors of future problems with emotion regulation. Moreover, through use of a longitudinal design, there was greater opportunity to acquire information regarding the causal direction of the relation between executive function and emotion regulation. Additionally, by specifically targeting children with behavior problems, I addressed a population that is at heightened risk for future emotional, behavioral, and social problems. In light of differences in developmental maturation between boys and girls, I also examined gender as a potential moderator. The goals of this study were addressed through two research questions.
**Research Question 1:** Does executive function at age 3 and 4 predict emotion dysregulation at age 5?

**Hypothesis 1:** Existing theory and cross-sectional research suggest that executive function plays an important role in the development of emotion regulation. Therefore, I hypothesized that better performance on executive function tasks measured when children were ages 3 and 4 would be predictive of less emotion dysregulation reported at age 5. More specifically, I predicted that worse performance within each domain of executive function (i.e., response inhibition, attentional control, working memory, and delay of gratification) would be linked to later problems with emotion dysregulation.

**Research Question 2:** Does executive function predict changes in emotion dysregulation across the preschool years?

**Hypothesis 2:** If executive function plays an important role in the development of emotion regulation, then early executive functions should affect subsequent growth in emotion regulation during the preschool years. To my knowledge, no studies had examined this possibility prior to the current study. Therefore, I hypothesized that performance within each domain of executive function will predict change in emotion regulation across the preschool year.

**Research Question 3:** Does gender moderate the relation between executive function and emotion dysregulation during the preschool years?

**Hypothesis 3:** Due to the fact that executive function and emotion regulation may develop at different rates in boys and girls, I hypothesized that gender would moderate the relation between each domain of executive function and later problems with emotion dysregulation.
CHAPTER 2

METHOD

2.1 Participants

Participants were 199 children (107 boys, 92 girls) and their 199 mother figures and 158 father figures who were drawn from a larger longitudinal study of preschool-aged children with and without behavior problems. In the present study, I focused on measures collected from children at age 3 ($M = 44.25, SD = 3.37$), age 4 ($M = 56.70, SD = 3.77$), and age 5 ($M = 69.31, SD = 4.24$). The sample included European American (49.7%), Latino American (21.6%; mostly Puerto Rican), African American (12.6%), and multiethnic (16.1%) children. The majority of mothers (84.4%) and fathers (88.8%) had high school diplomas, and 33.2% of mothers and 29.2% of fathers held a bachelor’s degree. The median income for families at the first time point was $47,110.

2.2 Procedure

Participants with significant externalizing problems were recruited from a sample of 3-year-old children ($N = 1,752$) whose parents completed a screening packet received through mail, pediatrician offices, childcare centers, and community centers. Inclusion criteria consisted of: (a) no evidence of deafness, blindness, intellectual disability, language delays, cerebral palsy, epilepsy, autism, or psychosis based on parent-reports; (b) parent-reported concern regarding the child’s activity level, defiance, aggression, or impulse control; and (c) Behavior Assessment System for Children-Parent Report Scale (BASC-PRS; Reynolds & Kamphaus, 1992) Hyperactivity and/or Aggression subscale $T$-scores of at least 65 (92nd percentile). Parents were informed that the goal of the study was to understand factors that help children with behavior problems outgrow their
difficulties. Assessments were conducted in the families’ homes at approximately one year intervals over three years beginning when children were 3-years-old. The present study was comprised of data obtained from the first three out of four time points. I received written consent from our participating families, and families were paid for their participation. The study was fully approved by an Institutional Review Board.

2.3 Measures

2.3.1 M&M task. The M&M delay task (Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996), a measure of delay of gratification given to preschoolers, was administered when children were 3 years old. The experimenter placed two M&Ms under one of three identical cups within arm’s length. The child was instructed to wait to find the M&Ms until the experimenter rang a bell. Six trials of this task were conducted, with the following delay periods: 10, 15, 25, 35, and 45 seconds. Children were given a score of 1 for each trial in which they were able to wait until the bell rang before finding the M&M, and a score on 0 for each trial in which they responded before the bell rang. Overall scores for this task are therefore out of a total of 6, with lower scores indicating greater delay aversion.

2.3.2 Present delay task. The Present task, a measure of delay of gratification, was adapted from Kochanska and colleagues’ (1996) battery of tasks and was administered to the children at the first time-point of this study when children were 3 years old. For this task, the experimenter placed a colorfully wrapped package within arm’s length of the child, telling the child that it could be open later. The child completed a simple puzzle while the experimenter pretended to do paperwork. If the child opened the present, the task was terminated with the time elapsed recorded as the
score. After five minutes, if the child had refrained from opening the present, the child was told that he/she could now open the gift.

2.3.3 NEuroPSYchological Assessment (NEPSY) subtests. Children’s “cool” executive functions were assessed during home visits when they were 4-years-old by subtests from the first edition of the NEPSY (Korkman, Kirk, & Kemp, 1998). This study will focus on the Statue, Sentence Repetition, and Visual Attention subtests as measures of response inhibition, working memory, and attentional control, respectively. All three tests were administered during the second time point of this study when the children were 4 years old. The Statue subtest requires the child to maintain a body position with eyes closed for 75 seconds while simultaneously inhibiting the impulse to respond to sound distractors. The child received 5 points for every 15 second interval he/she successfully inhibited response for a maximum total of 30 points. In the Sentence Repetition subtest, the child is read sentences and asked to recall each sentence immediately after it is presented. In the Visual Attention task the child is shown a target figure and asked to mark off that figure when the child sees it on the page. Test retest reliability for the Sentence Repetition and Visual Attention subtests are reported to be good for 4-year-old children (.84 and .76 respectively), though test-retest reliability for the Statue subtest is relatively low (.50; Korkman et al., 1998).

2.3.4 Conners’ Kiddie Continuous Performance Test (K-CPT). The K-CPT (Conners, 2001) is designed to assess response inhibition and attentional control in 4- to 5-year-old children. Children were tested on the K-CPT during the second time point of this study when children were 4 years old. The task consists of common objects flashing on a computer screen in either 1.5s or 3s stimulus intervals. The child is directed to press
the spacebar every time a common object appears unless a picture of a ball is displayed. The test lasts 7.5 minutes and is divided into five equal time blocks and then scores the child’s proficiency on 11 dimensions: Omissions, the number of pictures that the child incorrectly did not respond to; Commissions, the number of times the child made an incorrect response; Hit Reaction Time, overall response time in milliseconds; Hit Reaction Time Standard Error, average standard error across all block; Variability of Standard Error, a record of within-child variability of standard errors of reaction times between blocks; Attentiveness, a measurement of the child’s ability to discriminate targets from non-target pictures; Perseverations, the number of times the child responded in under 100ms intervals; Hit Reaction Time Block Change, slope of the reaction times from the first to fifth block; Hit Standard Error Block Change, slope of the Hit reaction times standard error between the two stimulus interval times (1.5 and 3 seconds); and Hit Standard Error ISI Change, the slope of change in reaction time standard errors between the two interval times. Additionally, the program calculates an ADHD Confidence Index after scoring the 11 dimensions. The K-CPT has demonstrated adequate reliability for 4-to 5-year old children and has been used to effectively differentiate children with and without ADHD (Conners, 2001).

2.3.5 BASC-PRS. Emotion dysregulation was assessed using the BASC-PRS Preschool Version (Reynolds & Kamphaus, 1992). The BASC-PRS is a comprehensive rating scale measuring many dimensions of both adaptive and problem behaviors in children between 2 years 6 months and older. The BASC-PRS has demonstrated good reliability for children 3 years and older (Reynolds & Kamphaus, 1992). This version of the BASC was given at all three time points of the present study. For the larger
longitudinal study, a separate version of the BASC designated for school-aged children was given at the fourth time point. However, I did not include the fourth time point because the BASC items differed, and there were not sufficient items that overlapped between the two versions to create a single measure of emotion dysregulation. For this study, I identified 16 items based on face validity that appear to be tapping at emotion dysregulation. A principal components analysis (PCA) with a promax rotation identified a two-factor solution reflecting externalizing emotions and internalizing emotions (see Table 1), with only 14 items loading onto these two factors. Eight items loaded onto the externalizing factor, which accounted for 31.83% of the variance (eigenvalue = 5.09). Six items loaded onto the internalizing factor, which accounted for 12.7% of the variance (eigenvalue = 2.03). These items were averaged to create an externalizing emotion dysregulation score and internalizing emotion dysregulation score.

2.4 Analytic Plan

Growth curve modeling was used to examine the relation between performance on tests of executive function and children’s emotion dysregulation. Hierarchical linear models (HLM) were used to estimate trajectories of BASC-PRS emotion dysregulation scores over time. Models were run separately for internalizing and externalizing emotion dysregulation scores using a two-level approach. The first level of analysis (Level-1) modeled individual growth trajectories of emotion dysregulation scores for each child, with emotion dysregulation scores regressed on time, $\text{EmotionDysregulation}_{ij} = \beta_{0j} + \beta_{1j} (\text{Age})_{ij} + r_{ij}$. Time was centered at age 5, so the intercept reflected children’s level of emotion dysregulation at age 5. The slope indicated children’s linear change over time, and the random effect indicated within-person deviation. These intercepts and
slopes were then regressed on each measure of executive function at Level 2, to evaluate whether executive function predicted both levels of emotion dysregulation at age 5, \[ \beta_{0j} = \gamma_{00} + \gamma_{01} EF_j + u_{0j}, \] and change in emotion dysregulation, \[ \beta_{1j} = \gamma_{10} + \gamma_{11} EF_j + u_{1j}, \] across children. Separate models were conducted for each measure of executive function. Additional models were estimated to assess whether gender was a significant moderator of the relation between each executive function and emotion regulation. Along with each measure of executive function, gender and the corresponding interaction term (e.g., Gender × Present) were added onto Level-2. If the interaction term was significant, the corresponding model was re-run separately for boys and girls.
CHAPTER 3

RESULTS

3.1 Descriptive Statistics

Means, standard deviations, and intercorrelations for executive function predictor variables and emotion regulation outcome variables are presented in Table 2. The two measures of response inhibition, Statue and K-CPT errors of commission, were not correlated. However, better performance on the Statue test was significantly associated with fewer errors of omission on the K-CPT. Statue performance was also associated with better performance on the Present task and inversely related to ADHD Confidence Index scores. The NEPSY Sentence task, a test of working memory, exhibited moderate positive associations with both delay of gratification measures and was negatively related to errors of omission and the ADHD Confidence Index. Omission errors were negatively correlated with commission errors, as well as performance on both the Present and M&M task. Omission errors were highly correlated with ADHD Confidence Index, because the ADHD Confidence Index includes omission errors. ADHD Confidence Index scores were negatively correlated with the Present task but were not correlated with the M&M task. The two delay of gratification measures were moderately positively associated with one another. As expected, BASC-PRS externalizing and internalizing emotion dysregulation scores at each time point were all correlated with each other, with the exception of Time 3 externalizing dysregulation scores and Time 1 internalizing dysregulation scores. Better performance on the Sentence task was associated with lower externalizing dysregulation scores at time 1. K-CPT errors of omission were positively
associated with higher externalizing dysregulation scores at each time point and higher internalizing dysregulation at the first time point.

3.2 Growth Curve Models

3.2.1 BASC-PRS unconditional models. Separate hierarchical linear models were used to estimate BASC-PRS externalizing and internalizing emotion dysregulation trajectories. I first ran unconditional models to assess changes in BASC-PRS scores across time. The intercept for BASC-PRS externalizing emotion dysregulation scores (which represents the level at age 5) was significantly different from zero, $\beta = 2.265$, $SE = .046$, $p < .001$, and the linear rate of change showed a significant decrease in BASC-PRS externalizing emotion dysregulation scores as children aged, $\beta = -.083$, $SE = .026$, $p = .001$. Results also showed significant variability in the rate of change across children, $\sigma^2 = .031$, $SE = .015$, $\chi^2(184) = 241.185$, $p = .003$. Similar to externalizing emotion dysregulation scores, the intercept for BASC-PRS internalizing emotion dysregulation scores (indicating the level at age 5) was significantly different from zero, $\beta = 1.640$, $SE = .035$, $p < .001$. However, the rate of change in internalizing emotion dysregulation scores was not significant, $\beta = .024$, $SE = .018$, $p = .195$. Results also showed significant variability in the rate of change of internalizing emotion dysregulation scores across children, $\sigma^2 = .014$, $SE = .007$, $\chi^2(184) = 234.690$, $p = .007$.

3.2.2 Predictors of BASC-PRS trajectories. The intercept and slope were regressed onto each executive function predictor, separately for each measure of executive function. Results for both externalizing and internalizing emotion dysregulation analyses are presented in Table 3. The majority of executive function predictors showed no significant relations with externalizing emotion dysregulation
intercepts (i.e., age 5 externalizing emotion dysregulation scores). However, greater K-CPT omission errors and better performance on the M&M task were associated with higher externalizing emotion dysregulation intercepts. Better performance on the Statue task was associated with lower externalizing emotion dysregulation intercepts at a probability level that approached significance. There were no significant associations between executive function predictors and children’s linear change in externalizing emotion dysregulation scores over time. There were no significant associations between executive function predictors and children’s BASC-PRS internalizing emotion dysregulation intercept nor any significant associations between executive function predictors and the linear rate of change in internalizing emotion dysregulation scores.

3.2.3 Gender as a moderator. I conducted additional analyses to examine if the relation between executive function performance and BASC-PRS scores differed in boys and girls. Similar to previous models, separate analyses were run for externalizing and internalizing emotion dysregulation BASC-PRS scores, and each executive function predictor was examined separately in its own model. In addition to the executive function predictor, each model now contained gender at Level-2, as well as the newly created interaction term (e.g., Gender × Visual Attention). Results from these analyses are presented in Table 4. The interaction was not significant in the majority of the models. However, two internalizing emotion dysregulation models (i.e., the slope of Visual Attention and the intercept of M&M) and one externalizing emotion dysregulation model (i.e., the intercept of Present) yielded significant interaction terms. For those significant interactions, I conducted additional analyses by re-running the models separating for boys and girls. Results are presented in Table 5.
Unconditional models for girls indicated that BASC-PRS externalizing emotion dysregulation intercepts were significantly different from zero, $\beta = 2.328, SE = .066, p < .001$, and scores significantly decreased as girls aged, $\beta = -.082, SE = .043, p = .059$. Likewise, for boys, BASC-PRS externalizing emotion dysregulation intercepts were significantly different from zero, $\beta = 2.213, SE = .061, p < .001$, and scores significantly decreased as boys aged, $\beta = -.082, SE = .029, p = .006$. Results also showed significant variability in the rate of change of externalizing emotion dysregulation scores across girls, $\sigma^2 = .070, SE = .027, \chi^2(80) = 146.480, p < .001$, but not for boys $\sigma^2 = .001, SE = .015, \chi^2(103) = 93.926, p > .500$. Similar to externalizing emotion dysregulation scores, BASC-PRS internalizing emotion dysregulation intercepts were significantly different from zero for both girls, $\beta = 1.671, SE = .047, p < .001$, and boys, $\beta = 1.618, SE = .051, p < .001$. Although the rate of change in BASC-PRS internalizing emotion dysregulation scores was not significant for girls, $\beta = .000, SE = .027, p = .997$, on average, there was a significant increase in internalizing emotion dysregulation scores as boys aged, $\beta = .047, SE = .023, p = .044$. Results also showed significant variability in the rate of change of internalizing emotion dysregulation scores across girls $\sigma^2 = .015, SE = .012, \chi^2(80) = 110.108, p = .014$, but not across boys, $\sigma^2 = .009, SE = .009, \chi^2(103) = 116.618, p = .170$.

For boys, better performance on the Visual Attention task was significantly associated with decreased emotion dysregulation internalizing slopes, $\beta = -.035, SE = .012, p = .004$, whereas there was no significant association between Visual Attention and internalizing emotion dysregulation slopes for girls, $\beta = .010, SE = .014, p = .479$. Performance on the M&M task was significantly associated with internalizing emotion
dysregulation intercepts for both girls, $\beta = .060$, $SE = .026$, $p = .025$, and boys $\beta = -.089$, $SE = .043$, $p = .042$, though in opposite directions. Thus, better performance on the M&M task was associated with higher internalizing emotion dysregulation intercepts and lower internalizing emotion dysregulation intercepts for boys. Finally, for girls, there was no significant association between the Present task and age 5 externalizing emotion dysregulation scores, $\beta = .033$, $SE = .040$, $p = .411$, whereas for boys, better performance on the present task was significantly associated with lower externalizing emotion dysregulation intercepts, $\beta = -.093$, $SE = .038$, $p = .016$. 
CHAPTER 4
DISCUSSION

The present study sought to longitudinally examine the relation between early executive function and later emotion dysregulation in young children with behavior problems. Results from the current study provide some support for the hypothesis that domains of executive function would be differentially linked to later symptoms of emotion dysregulation. More specifically, 3- and 4-year-olds with better delay of gratification skills exhibited fewer externalizing emotion dysregulation symptoms at age 5. Delay of gratification was also linked to internalizing emotion dysregulation symptoms when boys and girls were examined separately. Additionally, 3- and 4-year-olds with better attentional control exhibited fewer symptoms of externalizing emotion dysregulation at age 5. Furthermore, boys with better attentional control showed significant decreases in internalizing emotion dysregulation growth trajectories, whereas no significant relation was present for the girls. In contrast, response inhibition and working memory did not predict future emotion dysregulation or emotion dysregulation trajectories.

4.1 Delay of Gratification

In the current study, performance on both delay of gratification measures, the M&M task and the Present task, predicted later emotion dysregulation in young children with behavior problems. The finding that children who performed better on the M&M task exhibited fewer externalizing emotion dysregulation symptoms at age 5 corroborates evidence from previous longitudinal (Eisenberg et al., 2010) and cross-sectional studies (Carlson & Wang, 2007; Kalpidou et al., 2004; Liebermann et al., 2007) suggesting that
the ability to delay may be an early indicator of a child’s ability to regulate his or her emotions effectively. Due to the fundamental role of inhibitory control in delay of gratification tasks, this significant finding may appear to conflict with the absence of a significant link between measures of response inhibition and emotion regulation in the present study. Unlike measures of response inhibition, however, delay of gratification requires children to inhibit in the presence of reward. This finding validates the notion that reward exerts a unique influence on inhibitory capabilities and distinguishes delay of gratification tasks from other inhibitory tasks. This distinction is also substantiated neurologically (Zelazo & Carlson, 2012); whereas response inhibition tasks are associated with activation in more dorsal regions of the prefrontal cortex, delay of gratification tasks are linked to the most ventral regions of the prefrontal cortex, namely the orbitofrontal cortex (OFC). The OFC is activated in situations that contain a motivational significance, making it integral to tasks that include a delayed reward (Bechara & Damasio, 2001; Churchwell, Morris, Heurtelou, & Kesner, 2009; Shaw, Stringaris, Nigg, & Leibenluft, 2014; Wilbertz et al., 2012). At the same time, the OFC is also responsible for regulating emotions generated by the limbic system (Banks et al., 2007; Carmichael & Price, 1996). Thus, the significant link between inhibition in the context of reward and emotion regulation may stem from similar neural substrates underlying both processes.

4.2 Attentional Control

Despite the fact that numerous studies have previously linked attentional control and emotion dysregulation in samples of older children and adults (Derryberry & Reed, 2002; Johnson, 2009; Schmeichel & Tang, 2015), this study adds to a smaller body of
literature that has explored this relation in preschool-aged children. I found that more errors of omission on the K-CPT predicted more externalizing emotion dysregulation in preschool-aged children one year later. Additionally, for boys, better performance on the visual attention task significantly predicted decreases in internalizing emotion dysregulation growth trajectories whereas no relation was significant for the girls. These findings are consistent with Schultz et al. (2001) who found that attentional control in preschoolers predicted emotion situational knowledge measured one year later. Furthermore, the authors suggested that emotion knowledge is one tool children use to regulate their emotions. Taken together, these findings indicate that attentional control may help children acquire better emotion knowledge, which may, in turn, foster greater emotion regulation. Moreover, children likely rely on attention to filter their surroundings, allowing them to engage with positive stimuli and disengage with negative stimuli. This tool may be particularly valuable for young children who have less control over their surroundings. Attentional control uniquely equips children with some degree of autonomy over their environment: they cannot always choose their environment, but they can choose what they attend to in their environment.

To my knowledge, this is the first study to examine how specific domains of executive function predict trajectories of emotion dysregulation in young children. Interestingly, attentional control was the only executive function that significantly predicted trajectories of emotion dysregulation in the current study. One possibility for this pattern of findings is that attentional control matures more rapidly than other executive functions, making it an accessible and ideal tactic for effective emotion regulation. Indeed, previous research suggests that attentional control underlies the
development of other executive functions, emerging very early on in development and quickly stabilizing (Garon et al., 2008; Posner & Rothbart, 1998). Such abilities are especially critical to young children with behavior problems who are particularly vulnerable to patterns of emotion dysregulation.

It is important to note that although this study was longitudinal, it could not tease apart the direction of causality. Although the finding that attention control predicted subsequent emotion dysregulation is consistent with the notion that attention control plays an important role in emotional development, previous studies have found that early emotion regulation is predictive of later attention control. For example, in a study of toddlers, emotion regulation was linked to sustained attention measured 2 years later (Graziano et al., 2011). Another longitudinal study of toddlers similarly reported that early negative emotionality predicted attentional control 1 year later (Gaertner et al., 2008). More longitudinal research is needed that assesses both emotion dysregulation and executive function over multiple time points to tease apart the direction of causality.

4.3 Working Memory

This study’s failure to find a link between working memory and emotion dysregulation stands in contrast to two previous studies of preschool-aged children that reported a significant link between performance on working memory tasks and parent (Wang & Saudino, 2013) and observer (Leerkes et al., 2008) reports of emotion regulation. However, these findings are consistent with Liebermann et al. (2007) who found no significant relations between a working memory task and parent-reported emotion regulation of 3- to 5-year-old children. The ability to recall and hold emotion regulation strategies in memory may be important for successful execution of emotion
regulation in older children and adults, but this application of working memory may not yet be fully developed when children are just 3 and 4 years of age. Another explanation for these discrepant findings may be rooted in the multidimensional nature of working memory, which often involves recall, maintenance, and/or updating capabilities. This study focused on the role of recall and maintenance capabilities because updating capabilities are still developing in young children. Finding age appropriate measures of each dimension of working memory is challenging but may ultimately clarify the nature of its role in young children.

4.4. Response Inhibition

Similar to working memory, response inhibition was not linked to externalizing or internalizing emotion dysregulation at any time point in the current study. This finding stands in contrast to well-documented theory that the inhibition or restraint of an emotional response is paramount to successful emotion regulation. However, like working memory, this connection appears most salient in populations of older children and adults. For example, in a more recent study, Hudson and Jacques (2014) reported evidence linking response inhibition to emotion regulation in young children, but their sample was comprised of 5- to 7-year-olds. Although Carlson and Wang (2007) reported similar findings using a younger sample of 3- to 5-year-olds, several other investigations of preschool-aged children reported no significant links between these two constructs (Kieras et al., 2005; Leerkes et al., 2008). This non-significant finding may also be explained by the nature and complexity of response inhibition tasks. Similar to measures used in previous investigations, this study’s measure of response inhibition required the child to inhibit a response in accordance to a simple rule. However, in order for children
to continually remember this rule, they must rely on their working memory (Garon et al., 2008). This crucial first step may be particularly challenging for children as young as 3- and 4-years-old. Thus, performance on this task may reflect a child’s ability to inhibit a response, but it may also depend on a child’s ability to hold a rule in working memory. As mentioned previously, the link between working memory and emotion regulation may present itself at a later point in development, which may explain the current lack of significant findings.

4.5 Gender Differences

The results of the current study provide some support for gender differences in the link between executive function and emotion regulation. Concordant with previous research, the present study’s findings were generally mixed. No gender differences emerged between response inhibition and emotion regulation or working memory and emotion regulation. In contrast, gender differences emerged for both delay of gratification measures, as well as for one attentional control measure.

For delay of gratification, significant relations arose for both boys and girls but only on the M&M task; in contrast, for the Present task, significant relations emerged for boys only. More specifically, boys who performed better on the Present task exhibited fewer externalizing emotion dysregulation symptoms at age 5. This finding may be explained by existing theory that suggests that boys are more likely than girls to suffer from externalizing psychopathologies (Zahn-Waxler, Shirtcliff, & Marceau, 2008). Interestingly, for the M&M task, I found that performance on this task significantly predicted future internalizing emotion dysregulation but in divergent directions: boys with better performance on the M&M task were more likely to exhibit less internalizing
emotion dysregulation symptoms in the future, and girls with better performance on the M&M task exhibited more symptoms of internalizing emotion dysregulation. This finding corroborates existing theory that suggests that boys and girls exhibit dramatic differences in their presentation of internalizing psychopathologies and symptoms. It is also consistent with the notion that extreme levels of disinhibition and inhibition are both risk factors for internalizing emotional disorders (Zahn-Waxler et al., 2008). Pressure to conform on delay of gratification tasks may echo the social pressures girls face to temper unwanted responses in everyday life. Although this skill may be socially desirable and adaptive, it may also hint at maladaptive internalizing tendencies. At the same time, for boys, the ability to delay gratification may be less reflective of societal demands and more indicative of adaptive inhibitory functioning. Although questions still remain regarding the nature of delay of gratification tasks and whether or not they are dependent on emotion regulation abilities or, like the other executive functions, potentially predictive of emotion regulation abilities, the finding that girls who performed better on the M&M task exhibited more symptoms of emotion dysregulation suggests that these tests are not solely measures of emotion regulation.

Gender differences additionally emerged on one test of attentional control. For boys, better performance on the visual attention task was associated with better improvement in emotion dysregulation and more adaptive growth trajectories whereas no relation was significant for the girls. Existing theory may provide some explanation for the current findings. One explanation may be rooted in the idea that boys and girls follow different trajectories in their emotional development (Zahn-Waxler et al., 2008). In comparison to girls, boys may rely more heavily on attentional control to modulate
their emotions throughout their childhood. Although there is evidence to suggest that inattention is a risk factor for both boys and girls, boys may feel less pressure to conform to task demands. Consequentially, their performance may be a better reflection of their real-world disposition, allowing patterns and relations to emerge more readily.

These findings indicate that the link between executive function and emotion regulation may be more pronounced in preschool-aged boys than preschool-aged girls. For boys, better performance on attentional control tasks and better performance on delay of gratification tasks predicted more positive outcomes in emotion regulation. Previous research suggests that this pattern of findings may, in fact, be linked. More specifically, children may depend on attentional control to distract themselves during delay tasks, a strategy regarded as adaptive and “planful.” Passive strategies (e.g., focusing on the delay object), on the other hand, may similarly accomplish the task at hand, but they may be accompanied by increased negativity. One possibility is that, in comparison to girls, boys may be relying less on these passive strategies, instead opting for strategies rooted in attentional control. Conversely, girls may be employing more passive strategies, which may place them at greater risk for future problems with emotion regulation (Supplee, Skuban, Trentacosta, Shaw, & Stoltz, 2011).

Future longitudinal research should direct attention to identifying strategies for successful task completion in samples of children with behavior problems, as well as typically developing children. Comparing girls with behavior problems to a typically developing sample may also clarify if delay of gratification is linked to more symptoms of emotion dysregulation in girls on a whole or if this link is restricted to this particular subgroup of girls. Despite research suggesting that cognitive functioning may mature
faster in girls, girls may be socialized to use more passive problem-solving strategies than boys. Children may additionally mirror their parents’ coping strategies, and future research ought to explore this possibility more carefully.

4.6 Limitations

There are several limitations to the current study that should be considered. First, the measure of emotion dysregulation used in this study was derived from a measure typically used to assess behavior problems in young children, so this subset of items is not a validated scale of emotion dysregulation. An observational measure would be a helpful supplement to our parent-reports and may provide a more accurate measure of emotion dysregulation. Second, executive function was only measured at a single time point in the current study. This study’s longitudinal design may provide greater support for a causal link between executive function and emotion regulation than previous cross-sectional studies, but these findings do not determine the direction of the causality. Measuring executive function at every time point may clarify lingering questions pertaining to potential mutual influences between executive function and emotion regulation. Additionally, in the present study, some executive function measures were administered at age 3 while others were administered at age 4, so measuring each executive function at each time point would also allow us to compare development of each executive function across the preschool years. Third, each domain of executive function consisted of two tests, with the exception of working memory, which consisted of one test. Given the working memory domain of executive function is comprised of multiple subcategories (e.g., updating, maintenance), it may be helpful to add additional tests to measure those different layers. Fourth, a number of children were unable to
complete some of the executive function tests, like the K-CPT, thus limiting power during analyses. Lastly, although this sample was ethnically diverse, the extent to which the findings of this study may be generalized to a wider population is unclear, and results should be interpreted with caution.

4.7 Implications and Future Directions

Despite these limitations, the present study extends our knowledge of factors that may play a critical role in the emotional development of preschoolers with behavior problems. Identifying these factors early on may be especially critical for this subset of children who are at particular risk for future impairments in emotion regulation. This study contributes to a small body of literature that has investigated the multidimensionality of executive function in younger populations. These findings point to the role of two domains in particular--delay of gratification and attentional control--and more efforts should be dedicated to exploring how these domains may be linked. Targeting attentional control early on may help prevent maladaptive emotion regulation trajectories in children with behavior problems. This study also suggests that the relation between delay of gratification and emotion dysregulation differ and boys and girls, so additional research is needed to understand the underlying mechanisms behind this finding. Continued research aimed at identifying executive functions by specific domains may help clarify which aspects of executive function are particularly impactful to emotional development.
Table 1

*Factor Loadings based on Principal Component Analysis with Promax Rotation*

<table>
<thead>
<tr>
<th>BASC-PRS Item Externalizing</th>
<th>Externalizing</th>
<th>Internalizing</th>
</tr>
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<tbody>
<tr>
<td>Holds grudge</td>
<td>.367</td>
<td>.074</td>
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<td>Cries easily</td>
<td><strong>.760</strong></td>
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<tr>
<td>Is sad</td>
<td>.122</td>
<td><strong>.277</strong></td>
</tr>
<tr>
<td>Pouts</td>
<td>.598</td>
<td>-.016</td>
</tr>
<tr>
<td>Is nervous</td>
<td>.113</td>
<td><strong>.603</strong></td>
</tr>
<tr>
<td>Shows fear of strangers</td>
<td>-.094</td>
<td><strong>.691</strong></td>
</tr>
<tr>
<td>Gets very upset when things are lost</td>
<td><strong>.416</strong></td>
<td>.173</td>
</tr>
<tr>
<td>Worries about things that cannot be changed</td>
<td>.047</td>
<td><strong>.666</strong></td>
</tr>
<tr>
<td>Worries</td>
<td>-.046</td>
<td><strong>.774</strong></td>
</tr>
<tr>
<td>Is easily upset</td>
<td><strong>.792</strong></td>
<td>.023</td>
</tr>
<tr>
<td>Throws tantrums</td>
<td><strong>.840</strong></td>
<td>-.085</td>
</tr>
<tr>
<td>Gets upset when left in a new situation without a parent or caregiver.  Changes mood quickly</td>
<td>.138</td>
<td>.484</td>
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<tr>
<td>Is fearful</td>
<td>-.089</td>
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<tr>
<td>Whines</td>
<td><strong>.754</strong></td>
<td>-.041</td>
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<tr>
<td>Screams</td>
<td><strong>.842</strong></td>
<td>-.050</td>
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*Note.* Factor loadings >.20 are in boldface. BASC-PRS = Behavior Assessment System for Children-Parent Report Scale.
Table 2

*Descriptive Statistics for Executive Functions and Emotion Dysregulation Variables*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Girls</th>
<th>Boys</th>
</tr>
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<tr>
<td></td>
<td>N</td>
<td>M (SD)</td>
</tr>
<tr>
<td><strong>Executive Function</strong></td>
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</tr>
<tr>
<td>1. NEPSY Statue(^b)</td>
<td>161</td>
<td>10.40 (2.57)</td>
</tr>
<tr>
<td>2. NEPSY Sentence Repetition(^b)</td>
<td>165</td>
<td>10.19 (2.70)</td>
</tr>
<tr>
<td>3. NEPSY Visual Attention(^b)</td>
<td>159</td>
<td>10.36 (2.03)</td>
</tr>
<tr>
<td>4. CPT Commission Errors(^b)</td>
<td>111</td>
<td>55.39 (8.53)</td>
</tr>
<tr>
<td>5. CPT Omission Errors(^b)</td>
<td>111</td>
<td>53.75 (12.18)</td>
</tr>
<tr>
<td>6. ADHD Confidence Index(^b)</td>
<td>111</td>
<td>53.11 (18.05)</td>
</tr>
<tr>
<td>7. Present(^a)</td>
<td>163</td>
<td>3.80 (1.71)</td>
</tr>
<tr>
<td>8. M&amp;M(^a)</td>
<td>154</td>
<td>4.95 (1.57)</td>
</tr>
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<td><strong>Emotion Dysregulation</strong></td>
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<tr>
<td>BASC Externalizing</td>
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<tr>
<td>9. Time 1</td>
<td>198</td>
<td>2.45 (.58)</td>
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<tr>
<td>10. Time 2</td>
<td>181</td>
<td>2.30 (.51)</td>
</tr>
<tr>
<td>11. Time 3</td>
<td>126</td>
<td>2.30 (.60)</td>
</tr>
<tr>
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<tr>
<td>12. Time 1</td>
<td>197</td>
<td>1.59 (.45)</td>
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<td>13. Time 2</td>
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<tr>
<td>14. Time 3</td>
<td>126</td>
<td>1.64 (.46)</td>
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</tbody>
</table>

Note: NEPSY = NEuroPSYchological Assessment subtests; CPT = Conners’ Kiddie Continuous Performance Test; BASC = Behavior Assessment System for Children – Parent Report Scale.

\(^a\)Administered at age 3. \(^b\)Administered at age 4

\(^* p < .05. \(^{**} p < .01.\)
<table>
<thead>
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<th>Variable</th>
<th>1</th>
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<th>10</th>
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<td></td>
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<tr>
<td>3 NEPSY Visual Attention$^b$</td>
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<td>6 ADHD Confidence Index$^b$</td>
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<td>.23**</td>
<td>-.10</td>
<td>-.11</td>
<td>-.22*</td>
<td>- .34**</td>
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<td>-.11</td>
<td>.33**</td>
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</tr>
<tr>
<td>9 Time 1</td>
<td></td>
<td>-.19*</td>
<td>.06</td>
<td>-.05</td>
<td>.30**</td>
<td>.21*</td>
<td>-.27**</td>
<td>-.16*</td>
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<td>10 Time 2</td>
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<td>-.07</td>
<td>.04</td>
<td>.05</td>
<td>.26**</td>
<td>.16</td>
<td>-.15</td>
<td>-.12</td>
<td>.46**</td>
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<td>11 Time 3</td>
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<td>-.12</td>
<td>-.05</td>
<td>-.03</td>
<td>.23*</td>
<td>.08</td>
<td>-.10</td>
<td>-.25*</td>
<td>.45**</td>
<td>.60**</td>
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<td>.14</td>
<td>-.04</td>
<td>.22*</td>
<td>.13</td>
<td>-.07</td>
<td>.02</td>
<td>.37**</td>
<td>.16*</td>
<td>.02</td>
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<tr>
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<td>-.06</td>
<td>.08</td>
<td>.06</td>
<td>.15</td>
<td>.06</td>
<td>-.06</td>
<td>-.09</td>
<td>.24**</td>
<td>.37**</td>
<td>.18*</td>
<td>.60**</td>
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</tr>
<tr>
<td>14 Time 3</td>
<td>-.02</td>
<td>-.06</td>
<td>.05</td>
<td>-.05</td>
<td>.11</td>
<td>.01</td>
<td>.01</td>
<td>.09</td>
<td>.225*</td>
<td>.39**</td>
<td>.36**</td>
<td>.53**</td>
<td>.63**</td>
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</tbody>
</table>

Note: NEPSY = NEuroPSYchological Assessment subtests; CPT = Conners’ Kiddie Continuous Performance Test; BASC = Behavior Assessment System for Children – Parent Report Scale.

$^a$Administered at age 3. $^b$Administered at age 4

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

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### Table 4

**Executive Functions Predicting Age 5 Emotion Dysregulation and Linear Rate of Change of Emotion Dysregulation**

<table>
<thead>
<tr>
<th>Predictor</th>
<th>BASC-PRS Externalizing</th>
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<th>BASC-PRS Internalizing</th>
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<tr>
<td></td>
<td>Intercept, $\beta_{01}$</td>
<td>Slope, $\beta_{11}$</td>
<td>Intercept, $\beta_{01}$</td>
<td>Slope, $\beta_{11}$</td>
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<tr>
<td>NEPSY Statue$^b$</td>
<td>-.035 (.019)$^†$</td>
<td>-.006 (.011)</td>
<td>-.003 (.015)</td>
<td>-.007 (.008)</td>
</tr>
<tr>
<td>NEPSY Sentence</td>
<td>-.010 (.017)</td>
<td>.012 (.010)</td>
<td>-.015 (.014)</td>
<td>-.003 (.007)</td>
</tr>
<tr>
<td>NEPSY Visual</td>
<td>-.005 (.024)</td>
<td>-.011 (.014)</td>
<td>.004 (.019)</td>
<td>-.014 (.010)</td>
</tr>
<tr>
<td>CPT - Commission</td>
<td>.001 (.006)</td>
<td>.001 (.004)</td>
<td>.003 (.006)</td>
<td>.002 (.002)</td>
</tr>
<tr>
<td>CPT - Omission Errors$^b$</td>
<td>.010 (.005)*</td>
<td>-.002 (.003)</td>
<td>.006 (.004)</td>
<td>-.001 (.002)</td>
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<tr>
<td>ADHD Confidence</td>
<td>.002 (.003)</td>
<td>-.002 (.002)</td>
<td>.001 (.003)</td>
<td>-.001 (.001)</td>
</tr>
<tr>
<td>M&amp;M$^a$</td>
<td>-.076 (.031)*</td>
<td>-.013 (.019)</td>
<td>-.000 (.025)</td>
<td>.003 (.013)</td>
</tr>
<tr>
<td>Present$^a$</td>
<td>-.034 (.029)</td>
<td>.025 (.015)</td>
<td>-.005 (.023)</td>
<td>.008 (.011)</td>
</tr>
</tbody>
</table>

*Note: NEPSY = NEuroPSYchological Assessment subtests; CPT = Conners’ Kiddie Continuous Performance Test; BASC-PRS = Behavior Assessment System for Children – Parent Report Scale.*

$^a$Administered at age 3. $^b$Administered at age 4.

$^† p < .10. * p < .05. ** p < .01.$
<table>
<thead>
<tr>
<th>Test</th>
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<th>BASC-PRS Internalizing</th>
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<tr>
<td></td>
<td>Intercept, $\beta_{01}$</td>
<td>Slope, $\beta_{11}$</td>
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<td>NEPSY Statue$^b$</td>
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<tr>
<td>Gender</td>
<td>.355 (.416)</td>
<td>-.235 (.236)</td>
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<tr>
<td>Statue</td>
<td>-.034 (.026)</td>
<td>-.016 (.015)</td>
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<tr>
<td>Gender x Statue</td>
<td>-.016 (.039)</td>
<td>.024 (.022)</td>
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<td>NEPSY Sentence Repetition$^b$</td>
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<td>Sentence</td>
<td>-.001 (.025)</td>
<td>.015 (.014)</td>
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<tr>
<td>Gender x Sentence</td>
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<td>-.004 (.019)</td>
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<tr>
<td>NEPSY Visual Attention$^b$</td>
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<tr>
<td>Gender</td>
<td>-.285 (.520)</td>
<td>-.270 (.293)</td>
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<tr>
<td>Visual</td>
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<td>-.025 (.020)</td>
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<tr>
<td>Gender x Visual</td>
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<td>.026 (.028)</td>
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<tr>
<td>CPT-Commission Errors$^b$</td>
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<td>Gender</td>
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<td>Gender</td>
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<tr>
<td>Index</td>
<td>-.004 (.005)</td>
<td>-.005 (.003)</td>
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<td>Gender x Index</td>
<td>.011 (.007)</td>
<td>.004 (.003)</td>
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<td>M&amp;M$^a$</td>
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<tr>
<td>Gender</td>
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<td>M&amp;M</td>
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<td>Gender x M&amp;M</td>
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<td>Gender</td>
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<td>Present</td>
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<td>.010 (.021)</td>
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<tr>
<td>Gender x Present</td>
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<td>.028 (.030)</td>
</tr>
</tbody>
</table>

*Note:* NEPSY = NEuroPSYchological Assessment subtests; CPT = Conners’ Kiddie Continuous Performance Test; BASC-PRS = Behavior Assessment System for Children – Parent Report Scale.  
$^a$Administered at age 3. $^b$Administered at age 4.  
* $p < .05.$ ** $p < .01.$ *** $p < .001.$
Table 6
Significant Interactions Predicting Age 5 Emotion Dysregulation and Linear Rate of Change in
Emotion Dysregulation Separated by Gender

<table>
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<th>BASC-PRS Internalizing</th>
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<td>Intercept, $\beta_{01}$</td>
<td>Slope, $\beta_{11}$</td>
<td>Intercept, $\beta_{01}$</td>
<td>Slope, $\beta_{11}$</td>
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<td>Girls</td>
<td>-</td>
<td>-</td>
<td>.003 (.023)</td>
<td>.010 (.014)</td>
</tr>
<tr>
<td>Boys</td>
<td>-</td>
<td>-</td>
<td>-.004 (.029)</td>
<td>-.035 (.012)**</td>
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<td>Girls</td>
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<td>.011 (.018)</td>
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<td>-.089 (.043)*</td>
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<tr>
<td>Girls</td>
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<td>Boys</td>
<td>-.093 (.038)*</td>
<td>.011 (.018)</td>
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Note: NEPSY = NEuroPSYchological Assessment subtests; BASC-PRS = Behavior Assessment System for Children – Parent Report Scale.

$^a$Administered at age 3, $^b$Administered at age 4.

* $p < .05$, ** $p < .01$. 
REFERENCES


