

Emotion Regulation and Temper Tantrums in Preschoolers: Social, Emotional,
and Cognitive Contributions

by

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BA, Trinity Western University, 1996
MA, Trinity Western University, 1999

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Abstract

The purpose of this study was to examine the contribution of different aspects of executive function (EF) and social understanding to emotion regulation (ER), and the influence of these aspects of self-regulation on temper tantrums. A model of self-regulation is presented in which ER, EF, and social understanding contribute to self-regulatory competence. General cognitive (i.e., language) and emotional (i.e., temperamental emotional reactivity) measures are included to increase the specificity of the relation between ER and other aspects of self-regulation. ER, EF, and social understanding were also examined in relation to temper tantrums.

One hundred twenty seven preschool children and their parents completed batteries of ER, EF, and social understanding, as well as measures of verbal ability, temperament, and temper tantrums. This study extends previous research by including multitrait, multimethod assessment of EF, ER, and social understanding, and controlling for verbal ability and emotional reactivity. Exploration of temper tantrums offers a

unique illustration of the manner in which aspects of self-regulation contribute to everyday displays of strong emotion in preschoolers.

Overall, the results of this investigation provided evidence that aspects of EF and social understanding are related to ER and that these aspects of self-regulation are also related to temper tantrums. More specifically, this study makes three main contributions to understanding children's ER. First, there was evidence that EF and social understanding were related to ER even after individual differences in emotional reactivity and verbal ability had been removed. Affective social understanding, but not cognitive social understanding, was a useful predictor in the regression model. Among the EF variables, there was evidence that individual differences in both response and delay inhibition contributed significantly to ER. This finding replicates and extends Carlson and Wang's (2007) findings of partial correlation (controlling for verbal ability) between inhibitory control and ER. Second, individual differences in both delay inhibition and ER contributed to the prediction of temper tantrums, even after controlling for emotional reactivity. Social understanding variables were not included in this analysis because correlations between social understanding and temper tantrums were low. Finally, mediation analysis provided evidence that ER significantly buffers the effect of emotional reactivity on temper tantrums. That is, the effect of emotional reactivity on temper tantrums was significantly reduced by ER. This effect remained even after controlling for age. These findings suggest that inhibitory control and affective social understanding make unique contributions to understanding ER and that temper tantrums are related to inhibitory control and ER.

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Dedication

To Pamela, Sarah, and Rachael who have been the wind beneath my wings.

Introduction

One of the central tasks of early childhood is the development of dependable self-regulatory competencies (Bronson, 2000). The capacity for conscious and voluntary control over our cognitive, emotional, and behavioural resources is central to our understanding of what it means to be human. Self-regulation underlies the dual concepts of freedom and responsibility which guide our sense of morality and justice. Our abilities to self-regulate also have far-reaching implications for individual achievement. Mischel and colleagues (Mischel, Shoda, & Rodriguez, 1989), for example, have shown that the number of seconds preschoolers are willing to wait for two marshmallows rather than settling for one immediately, predicts their cognitive and social outcomes decades later, including Scholastic Aptitude Test scores. Furthermore, preschoolers who fail to develop satisfactory management strategies for their behaviours and emotions are at risk for developing behavioral disorders (Cole, Michel, & Teti, 1994; Dodge & Garber, 1991). The development of self-regulatory competencies has far-reaching implications for individual developmental trajectories. Research on the development of self-regulation during the preschool years is, therefore, an important undertaking.

The model of self-regulation proposed here (see Figure 1) holds that the development of self-regulatory competencies in young children depends on the confluence of many aspects of child functioning, including: (a) emotional processes, and in particular, emotional reactivity (i.e., temperament) and emotion regulation (ER), (b) cognitive abilities, including executive function (EF) and language abilities, and (c) social competencies, including social skills and social understanding. These cognitive, affective, and social functions facilitate the application of goal directed regulatory efforts

and the coordination of individual and social actions toward common goals. Other factors, such as physical maturation, sensory-motor development, and motivational abilities are also important, but will not be considered here (for discussion of these factors, see Bronson, 2000). Although there is broad agreement among developmentalists that these factors conjointly influence self-regulation, most work to date has focussed on individual aspects of self-regulation. The goal of the present research was to examine the importance of cognitive and social-cognitive aspects of self-regulation for regulation emotion and to explore the influence these regulatory functions on the expression of temper tantrums in preschoolers.

In the sections that follow, I begin by sketching in broad terms a view of self-regulation that incorporates self-regulatory processes related to ER, EF, and social understanding. I distinguish these conscious and voluntary self-regulatory processes from constitutionally based emotional reactivity and from language abilities, which may also impinge on self-regulation. Next, I discuss the theoretical and empirical relations between ER and different aspects of EF and social understanding. Finally, I explore relations between different aspects of self-regulation and temper tantrums. Temper tantrums may offer insight into the everyday functioning of self-regulation.

Self-Regulation as a Conceptual Rubric

Self-regulation is a general term that subsumes conceptually distinct processes related to cognitive, social-cognitive, and emotional control. It serves as a broad conceptual rubric for understanding the coordination of regulatory efforts that have traditionally been assigned to cognitive, emotional, or social domains. Self-regulation encompasses those efforts individuals exert in order to accomplish their goals. Although

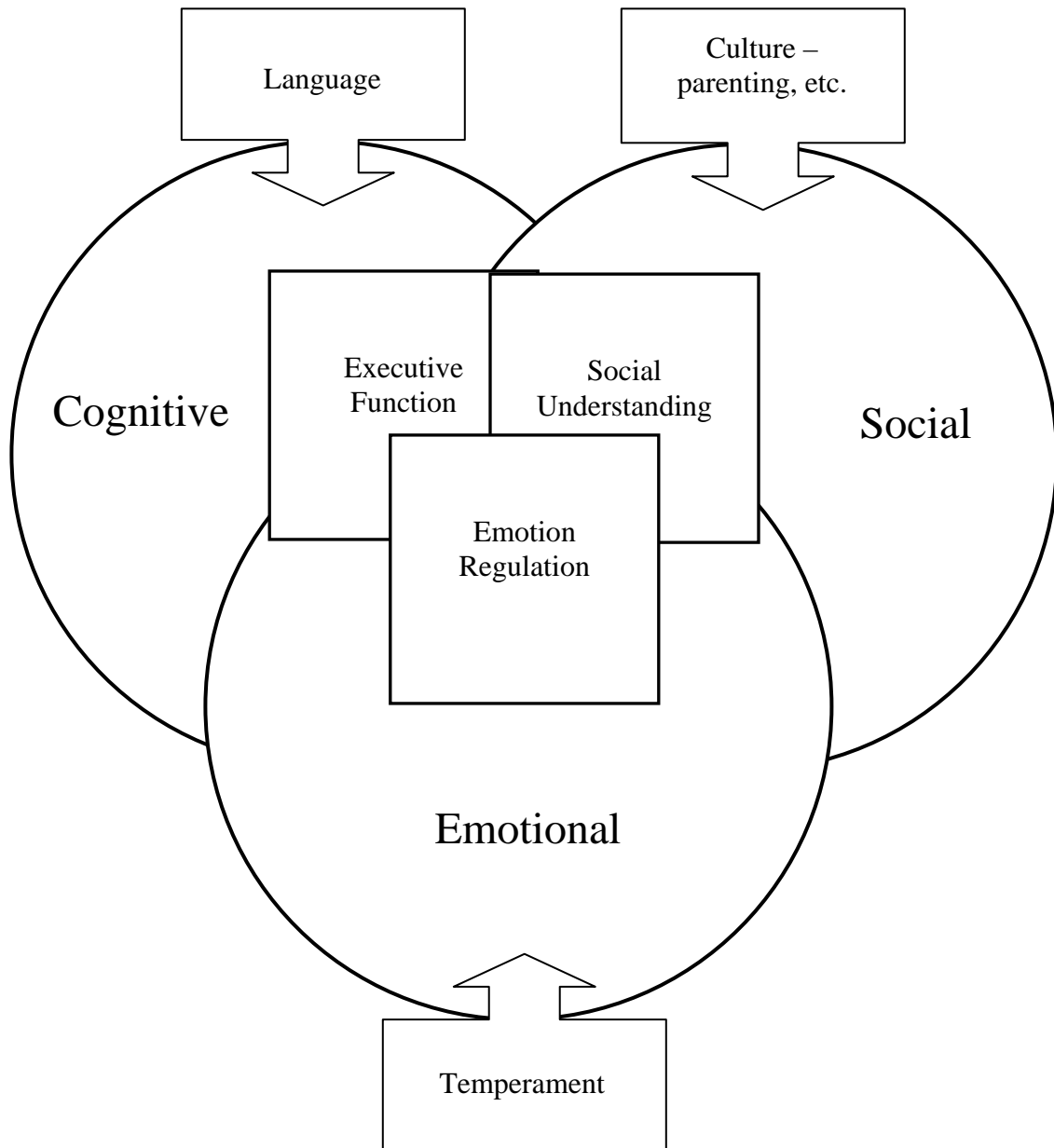
there is evidence to show that some self-regulatory processes are automatic and operate with little conscious control (Bargh, Gollwitzer, Lee-Chai, Barndollar, & Trotschel, 2001; Fitzsimons & Bargh, 2004), the focus of this study is on those processes that reflect voluntary control of cognition, emotion, and behaviour. Accordingly, the model of self-regulation I adopt here is one in which ER, EF, and social understanding contribute to adaptive problem solving. Figure 1 depicts this conceptual model. The large round circles represent the developmental interaction of cognitive, social and emotional domains. The squares within each circle represent the regulatory processes associated with each of these domains. They are depicted as overlapping, suggesting that ER, EF, and social understanding are functionally interdependent regulatory processes. Finally, the block arrows intersecting each domain represent specific factors that impact regulatory functioning but that are not in themselves considered to be components of the self-regulatory structure. In the sections that follow, I examine each of these aspects of self-regulation with a particular focus on their influence over the regulation of emotions and their usefulness for understanding temper tantrums.

Emotion Regulation¹

ER is integral to self-regulation because emotional arousal has the potential to foster or thwart self-regulatory action (Izard & Kobak, 1991). Within the broader construct of self-regulation, ER refers to processes that are responsible for monitoring, evaluating, and modifying emotional reactions in keeping with an individual's self-regulatory goals (Thompson, 1994). ER helps to safeguard individuals from

¹ In order to limit the scope of this study, my review of the ER construct and use of measures is limited to the down-regulation of negative emotion. Readers interested in the regulation of positive emotions should consult Fredrickson (2001).

Figure 1. Conceptual model of self-regulation



Notes: The large round circles represent the developmental interaction of cognitive, social and emotional domains. The squares within each circle represent the regulatory processes associated with each of these domains. They are depicted as overlapping, suggesting that ER, EF, and social understanding are functionally interdependent regulatory processes. Finally, the block arrows intersecting each domain represent specific factors that impact regulatory functioning but that are not in themselves considered to be components of the self-regulatory structure.

uncomfortably high levels of pleasurable excitement or untoward distress. Achieving a comfortable range of emotional homeostasis is important for establishing and maintaining social relationships and for priming emotional readiness to learn (Kopp & Neufeld, 2003). Children who are unable to maintain emotional arousal that is appropriate to the context display deficits in social skills (Eisenberg et al., 1997), school adjustment and progress (Blair, 2002), and are at risk for internalizing and externalizing problems (Calkins & Howse, 2004).

The nature and definition of ER are contested in academic discourse (cf., Cole, Martin & Dennis, 2004; Campos, Frankel & Camras, 2004). One reason for disagreement is related to the difficulty of translating the conceptual model of ER into a measurement model. Evidence for the activation and modulation of emotion, for example, are often inferred from the same behaviours. Since the activation and modulation of emotion are conceptually distinct, researchers have developed research designs that aim at assessing emotional activation independently of its modulation. The primary approach to this problem in early child development has been to separately assess children's emotional expressiveness (i.e., spontaneous emotional displays in a structured situation, or observer ratings of typical emotionality) and regulatory capabilities (i.e., purported regulatory strategies in a structured situation, or observer ratings of emotional control) using carefully crafted procedures and measures that strengthen the inferences that the observed behaviours were indeed examples of emotional activation or regulation (Cole et al., 2004). This approach is exemplified in Saarni's (1984) classic disappointing gift paradigm. In this task, children's emotional display following the receipt of a disappointing gift is compared to their emotional

display following a desirable gift. Various adaptations of this task have strengthened the inferences that children who smile when receiving a disappointing gift are actually regulating the expression of disappointment (Cole, 1986; Cole, Jenkins, & Shott, 1989; Cole, Zahn-Waxler, & Smith, 1994; Davis, 1995; Garner & Power, 1996; Josephs, 1994).

Evidence from the study of infant temperament further supports the need to make a distinction between emotional expression and regulation. The concept of temperament has been used to describe individual differences in constitutionally based tendencies to react to challenging events in ways that can be used to characterize an individual's response style (Kagan, 1994). Although researchers do not agree on the specific nature or basis of these individual differences, they do agree that differences in the ways children experience and express emotions are a core component of temperament (Goldsmith, et al., 1987). Rothbart (1981), for example, has proposed a model of temperament in which emotional reactivity (i.e., the threshold, intensity, and duration of affective arousal) is distinguished from voluntary processes of attentional self-regulation (i.e., effortful control). Rothbart's model highlights the need to separate processes of emotional arousal from processes that modulate emotional arousal.

Infancy and early childhood are developmental periods in which reactive emotional systems are relatively developed but regulatory systems are relatively weak (Sroufe, 1995). As a result, infancy and early childhood are often characterized by both exuberance and negativity (Denham, 1998). Emotional reactivity is an important construct for ER researchers because children who react to stressors with a high degree of negative emotionality tend to also demonstrate a higher degree of problem behaviours than their less reactive peers (Eisenberg et al., 2000). That is, highly reactive children

may have more difficulty regulating their emotions. The vast majority of child development research has focussed on processes that contribute to the down-regulation of negative emotion, perhaps because negative emotionality is stressful for both caregivers and children (Kopp, 1989).

The relation between emotional reactivity and ER has been examined in a number of studies that suggest uncontrolled emotional expression constrains the development of regulatory behaviours (Calkins, 1994; Calkins, Dedmon, Gill, Lomax, & Johnson, 2002). Consequently, emotional reactivity is a risk factor for social and externalizing problems (Belsky, Friedman, Hsieh, 2001; Blair, Denham, Kochanoff, & Wipple, 2004). The effects of negative reactivity on child outcomes, however, appear to be moderated by self-regulatory abilities (Eisenberg, Fabes, Bernzweig, Karbon, Poulin, & Hanish, 1993). Longitudinal studies by Eisenberg and colleagues (Eisenberg et al., 1997) suggest that emotional reactivity and ER make independent contributions to children's social development. These findings support the argument put forward by Cole et al. (2004) that research designs should distinguish between the activation and regulation of emotion. Accordingly, the research design adopted here incorporates multiple measures of both emotional reactivity and ER to help clarify the unique relations between ER and other aspects of self-regulation while taking into account children's general level of emotional responsiveness.

Emotion is a complex and multifaceted process and therefore can be regulated by diverse means. Accordingly, diverse measures of ER have been incorporated into research. The spectrum of these measures ranges from psychophysiological measures (e.g., EEG and fMRI) to introspective reports. The child development literature has

relied primarily on behavioural measures of emotion. Examples of these measures include coping behaviours that are contingently related to changes in emotion (e.g., shifting attentional focus; Grolnick, Bridges, & Connell, 1996) and facial display of emotion. Measures of the expressive display of emotion have been used in combination with the Disappointing Gift task described earlier. The basic premise that emotion can be reliably identified from rapid changes in the face has been conclusively shown in research with adults (Ekman & Friesen, 1975). Procedures for measuring facial display of emotion in young children have also yielded reliable results (Cole, 1986; Cole et al., 1989; Cole et al., 1994; Davis, 1995; Garner & Power, 1996; Josephs, 1994). These procedures are especially useful with young children because they are unobtrusive and young children tend to directly display their emotion with relatively less monitoring of their expressive behaviour than older children and adults (Saarni, 1984).

To summarize, ER is a process of modulating emotion that can be distinguished from emotional activation. It is important to separately measure ER and emotional reactivity in order to strengthen inferences about the regulation of emotion. Procedures for reliably measuring the activation and modulation of emotion in young children are currently in use by emotion researchers.

Executive Function

EF has been defined as the “psychological processes involved in the conscious control of thought and action” (Zelazo & Müller, 2002, p. 445). These processes are associated with operations of the prefrontal cortex (Zelazo, Carter, Reznick, & Frye, 1997). EF is an umbrella term for a diverse set of interrelated higher-order cognitive processes, including the inhibition of prepotent responses, set-shifting, error detection

and correction, working memory, and planning (e.g., Huizinga, Dolan, & van der Molen, 2006; Roberts & Pennington, 1996; Welsh, Pennington, & Groisser, 1991). Factor analytic studies (Lehto, Juujarvi, Kooistra, & Pulkkinen, 2003) and clinical studies (Ozonoff, 1997; Pennington & Ozonoff, 1996; Sergeant, 2000) support the view that EF is multicomponential. The most widely accepted components of EF include shifting/flexibility, inhibitory control, and updating/working memory. In the following sections, each of these aspects is reviewed and their potential importance to ER is highlighted.

Shifting/flexibility. The ability to shift focus from one aspect of a problem to another or to shift perspectives from one representation to another is a fundamental requirement for cognitive control. Attentional flexibility, for example, may involve the ability to engage and disengage appropriate task sets “but may also (or even instead) involve the ability to perform a new operation in the face of proactive interference or negative priming” (Miyake et al., 2000, p. 56). According to this perspective, attentional flexibility helps to ensure that problem solving efforts focus on the most appropriate information or aspects of a problem (Fernandez-Duque, Baird, & Posner, 2000). Likewise representational flexibility (i.e., shifting from one perspective or set of rules to another) is a core requirement for success on a variety of EF and social understanding tasks (Müller, Zelazo, & Imrisek, 2005). The dual processes of attentional and representational flexibility allow children to selectively attend to the key components of a problem and to view the problem from multiple perspectives.

One task that has been developed to assess shifting abilities in young children is the Dimensional Change Card Sorting Task (DCCS) (Frye, Zelazo, & Palfai, 1995).

Briefly, the DCCS is a sorting task that assesses children's flexible rule use. Children are given cards that differ along two dimensions (i.e., colour and shape) and must flexibly shift between sorting according to these two dimensions. Children begin the task by sorting according to one simple rule (i.e., "In the colour game, if it's blue then it goes here but if it's red then it goes there"). In the next phase, they must switch to use a new rule (i.e., "In the shape game, if it's a boat then it goes here but if it's a rabbit then it goes there"). Whereas typically developing 3-year-olds tend to perseverate on the first rule, 4-year-olds flexibly shift to the new rule (Zelazo, 2006).

Evidence of shifting abilities among very young infants suggests that it is a primary aspect of ER. Kopp (1982), for example, suggests that shifts in visual attention observed in neonates are a rudimentary precursor to ER (for a summary and comparison of different theories of attention regulation in infancy, see Kopp, 2002). Although visual shifts in attention do not speak directly to the question of how executive shifts of attention may be related to ER (in part because executive and visual attention systems may be regulated by different areas of the brain and have different developmental timetables [Posner and Raichle, 1994; Rothbart, Ziaie, & O'Boyle, 1992]), they do establish a primary developmental link between shifting and ER.

The broader theoretical context for the link between shifting abilities and ER can be derived from a recent model of evaluative processing proposed by Cunningham and Zelazo (2007). The iterative-reprocessing model proposes that evaluations (i.e., one's current appraisal of situations) are processed through hierarchically nested neural networks. According to this view, emotions are lower-order evaluative processes that provide low-resolution evaluations of situations and innervated primarily by the limbic

system. Higher-order processes, originating primarily in the prefrontal cortex, are recruited through subsequent iterations of the evaluative processes to yield more nuanced stimulus and contextual construals that have the potential to be based on a wider range of contexts and considerations. With each additional iteration, new appraisals can be generated as new representations and contextual information are activated or foregrounded by higher-order processes to help construct more carefully considered evaluations.

Applied to the problem of regulating emotion, the iterative-reprocessing model suggests that ER requires reprocessing the first-pass, quick-and-dirty appraisals of stimuli and situations. Rapid emotional responses have an obvious survival value, but this efficiency comes at the cost of considerable narrowing in the available perceptual and contextual information. In fact the efficiency of emotional responses depends on their ability to focus attention on certain focal aspects of the stimulus or situation (e.g., “is this threatening or safe?”) and to ignore less immediately salient aspects (e.g., “how did I deal with this last time?”) (Ohmen, 2002). The abilities to shift from one representation to another or to shift focus from one aspect of the problem to another contribute to ER by enabling the foregrounding and backgrounding of perceptual and contextual information that can be used to modulate the experience and expression of emotion.

Rothbart and others (e.g., Rueda, Posner, & Rothbart, 2005; Eisenberg, Shepard, Fabes, Murphy, & Guthrie, 1998; Eisenberg, Smith, Sadovsky, & Spinard, 2004), have proposed that attentional control (i.e., the ability to voluntarily focus or shift attention as needed) plays a crucial role in the regulation of reactive temperamental tendencies. Simmonds, Kieras, Rueda, & Rothbart (2007), for example, found that executive

attention abilities were related to the ability to substitute a smile for feelings of disappointment in a mistaken gift task. Other studies demonstrating the link between emotional and attentional control support the notion that shifting abilities contribute to ER (Fox and Calkins, 2003; Morales, Mundy, Crowson, Neal, & Delgado, 2005). In summary, there is support for the proposal that attentional and representational flexibility make an important contribution to ER.

Inhibitory control. Closely related to shifting abilities, inhibitory processes are central to self-regulatory efforts. Executive inhibition can be defined as “processes for intentional control or suppression of response in the service of higher order or longer term goals” (Nigg, 2000, p. 238)². A variety of methods have been used to assess inhibition, including Go/nogo tasks – in which individuals respond to some stimuli but not others (e.g., Johnstone et al., 2007), Stroop tasks – in which individuals are required to withhold a prepotent response and substitute another response (e.g., Berlin & Bohlin, 2002), and delay tasks – in which individuals must suppress the natural desire to retrieve a desirable object (e.g., Mischel et al., 1989). All of these executive inhibition tasks require the substitution of a desired response (or non-response) for a cued or prepotent response.

Everyday examples of executive inhibition include waiting for someone to finish a phone conversation before telling them some exciting news, or suppressing the natural tendency to laugh when someone falls awkwardly. According to Baumeister and colleagues (e.g., Baumeister, Bratslavsky, Murvan, & Tice, 1998; Tice & Bratslavsky,

² The term “inhibitory control” is ambiguous because it has been used to refer to many conceptually distinct psychological processes. Within Nigg’s (2000) taxonomy, executive inhibition captures those cognitive and effortful aspects of inhibition that are generally associated with conscious, goal directed behaviour. Use of the term “executive inhibition” is intended to focus the present discussion on those higher order cognitive processes that are linked to conscious self-regulation.

2000), the core function of self-regulation is to effect a substitution or reversal of an appetitive or natural tendency for another response, or lack of response. In the context of ER, response inhibition may help individuals prevent the activation of an emotion (Butler & Gross, 2004), suppress its amplitude or duration (Thompson, 1994), or substitute one emotional expression for another (Campos, Mumme, Kermoian, & Campos, 1994). Executive inhibition, therefore, plays a central role in the self-regulation of emotion.

The basis for postulating a fundamental link between executive inhibition and ER derives primarily from the status of emotion within affective self-regulation. As noted previously, emotions are rapid appraisal and action systems that register the significance of events and prepare the body for an organized response to the challenges presented by these events. Emotions are evolutionarily prepared adaptive responses that are both rapid and efficient in their use of cognitive resources. In this sense, emotions are prepotent responses. From this perspective, all forms of ER involve some form of inhibitory control. Inhibitory control creates opportunities for slower and more reflective appraisal processes to intervene between stimulus and response and through these more considered appraisals individuals may substitute desirable responses in place of prepotent emotional responses (Lewis & Todd, 2007).

To date, studies examining the relation between ER and EF has focussed on inhibitory control. A number of studies using the disappointing gift tasks have reported that executive inhibition is related to the up-regulation of positive emotion after receiving a disappointing gift (Kieras, Tobin, Graziano & Rothbart, 2005), as well as the suppression of negative displays of emotion (Carlson & Wang, 2007; Liebermann, Giesbrecht, & Müller, 2007). In addition, Hoeksma, Oosterlaan, and Schipper (2004)

reported that executive inhibition was related to adolescent's ability to regulate anger. These studies suggest that executive inhibition and ER may be interconnected abilities.

Updating/working memory. Updating/working memory (updating/WM) refers to “a limited capacity system allowing the temporary storage and manipulation of information necessary for such complex tasks as comprehension, learning and reasoning” (Baddeley, 2000, p. 418). Among other things, updating processes involve monitoring and coding incoming information for relevance to current goals and then appropriately revising the items held in working memory by replacing old, no longer relevant information with newer, more relevant information (Morris & Jones, 1990).

Within the self-regulation (Bandura, 1991) and EF (Welsh & Pennington, 1988) literatures, updating/WM is sometimes referred to as *self-monitoring*, and has at least two functions, both of which are related to the concept of feedback. The first function of updating/WM is to provide feedback concerning the need for and quality of regulatory efforts. How and when to modify cognition, emotion, or behaviour depends critically on a variety of factors (i.e., the surgency and strength of the initial emotion, alternate viewpoints that can be constructed, secondary emotions that may arise as a result of the initial emotion, etc.) that must be taken into account. Self-monitoring of ongoing cognitive, emotional, and behavioural processes therefore provides moment-by-moment information concerning the need to initiate, maintain, or terminate regulatory attempts.

The second and related function of updating is to detect discrepancies between a standard or goal for action and the current status of actions. This aspect of self-monitoring is clearly exemplified by cybernetic models of self-regulation, such as a test-operate-test-exit (TOTE) system (Miller, Galanter, & Pribram, 1960, as cited in Carver &

Scheier, 1990). In the initial ‘test’ phase, a person compares his or her current emotional state, for example, to a desired emotional state. If a discrepancy is noted, the ‘operate’ phase is initiated through regulatory actions intended to move the system toward the desired end state. Progress toward the goal is monitored by further ‘test’ phases. This process continues until the initial discrepancy has been resolved and the TOTE process is terminated.

Empirical evidence for the role of updating/WM processes in self-regulation comes from a variety of fields including education (Gottman & McFall, 1972; Tomarken & Kirshenbaum, 1982), athletics (Williams, Donovan, & Dodge, 2000), psychotherapy (Febbraro & Clum, 1998), psychopathology (Stevens, Quittner, Zuckerman, & Moore, 2002), information processing (Towse, Lewis, & Knowles, 2007), self-regulated learning (Paris & Newman, 1990), and moral judgment (McClure, Botvinick, Yeung, Greene, & Cohen, 2007). Updating/WM may also play an important role in the co-developments of social understanding and EF (Carlson, Moses, & Breton, 2002). Although specific aspects of self-monitoring figure prominently in at least one theory of ER (Carver & Scheier, 1982, 1990, 1998), little attention has been given to the role this mechanism may play in regulating emotion.

Self-monitoring of emotional arousal and regulation is initially performed almost entirely by caregivers (Kopp, 1989; Sroufe, 1995). Independent self-monitoring is achieved only after a prolonged period of apprenticeship under the guidance of more capable social partners (Bronson, 2000). For example, research by Sigel and colleagues (Sigel, Stinson, & Flaugh, 1991) suggests that parents use discrepancy signaling as a distancing strategy to help children become cognitively engaged in problem solving.

Discrepancy signaling involves using questions or statements to help children perceive the discrepancy between their actual behaviours and their intended behaviours or the social standard for behaviours. Kopp's (1982; 1989) developmental model also emphasizes the importance of self-monitoring for developing emotional competence because the ability to incorporate updating/WM skills into regulatory efforts signals an important transition from externally mediated regulation to internally mediated regulation.

To summarize, there are reasons to believe that shifting, inhibitory control, and updating/WM contribute to the development and application of ER. Empirical evidence of a link between inhibitory control and ER strengthens this assertion. Previous research, however, has not examined the nature of the relation between ER and other aspects of EF. The present study addresses this gap.

Social Understanding

Social understanding refers to the notion that people understand their own and others' actions in terms of mental states – beliefs, desires, intentions, emotions, and other inner experiences (Premack & Woodruff, 1978). In developmental psychology, social understanding has primarily been studied in terms of theory of mind (ToM), and more specifically false belief understanding. In the classic false belief task developed by Wimmer and Perner (1983), a doll named Maxi hides a chocolate in a cupboard and then leaves for the playground. During his absence, Maxi's mother moves the chocolate to another cupboard. When Maxi returns, he is hungry and wants to retrieve the chocolate. In order to correctly answer the question "where will Maxi look for the chocolate?" children must recognize that Maxi has a mistaken representation of the situation which

will lead him to search in an incorrect location (Moses & Carlson, 2004). Whereas typically developing 3-year-olds have difficulty coordinating their own knowledge of the chocolate's actual location with Maxi's false belief, 4-year-olds do not display this difficulty (Wellman, Cross, & Watson, 2001). Studies with preschoolers have confirmed that by 4 years of age, most typically developing children are able to understand that people act in accordance with their beliefs, even when those beliefs are incorrect (Astington, 1993). This transformation in children's understanding of mental states has led some to conclude that an important conceptual change occurs at the end of the preschool years (Wellman et al., 2001).

Developmental advances in preschool children's understanding of the mind and their relation to metacognition have been well documented (Moses & Tahiroglu, in press; Perner & Lang, 1999). In contrast, relatively little attention has been focussed on children's understanding of emotion and how developments in emotion understanding are related to ER. At present, it is not clear whether emotion understanding should be considered an aspect of ER or an aspect of social understanding. Although there is evidence that emotion understanding and ER co-develop (Carlson & Wang, 2007; Denham, 1998), the procedural similarities between measures of emotion understanding and false belief tasks suggests that it may be more appropriate to conceptualise emotion understanding as an aspect of social understanding (Wellman & Liu, 2004).

Social understanding, like other forms of higher order cognition, develops gradually during childhood and within the context of relationships with caregivers (Carpendale & Lewis, 2004). Infants' ability to share emotional states (i.e., primary intersubjectivity) and their ability to use other people's emotional expressions toward

objects to inform their own understanding (i.e., social referencing) emerges well before explicit understanding of mental states (Rochat & Straino, 1999). In other words, infants and very young children understand other people's actions at first in terms of emotions and desires and only later do they come to incorporate the notion of belief into their understanding of why people behave the way they do (Bartsch & Estes, 1996). This developmental progression has an important implication for differentiating between affective and social understanding; understanding of cognitive states arises through an earlier understanding of emotional states (Dunn, 2000). Accordingly, it is important to distinguish between cognitive and affective aspects of social understanding because they may have different implications for the development of ER. Studies showing that false belief understanding and emotion understanding are related but distinct aspects of social cognition support this proposal (Cutting & Dunn, 1999). At minimum, cognitive and affective aspects of social understanding may uniquely contribute to children's understanding of mind.

Affective social understanding. Evidence that affective social understanding has a salutary effect on early emerging self-regulation can be found in studies of social referencing. Social referencing refers to the phenomenon that infants perceive and utilize affective cues displayed by caregivers to interpret the significance of situations. For example, in novel or ambiguous situations infants orient toward caregivers and utilize affective information embedded in the caregiver's facial, postural, and/or vocal tone to influence their own response to the situation (Feinman, 1982). These affective cues assist infants by providing an interpretation of the situation that infants can use to form their own understanding of the situation. Numerous studies examining social referencing in a

variety of settings have strengthened the conclusion that infants use social referencing to regulate their approach and avoidance behaviours (Hormk, Risenhoover, & Gunner, 1987; Sorce, Emde, Campos, & Klinnert, 1985; Walden & Ogan, 1988). Furthermore, functionalist theories of emotion propose that social cognition is a key component of emotional appraisals (Campos et al., 1994).

Parents' expressions of emotion can also teach children specifically about emotions and emotion regulation. Talking about emotional experiences and the emotional consequences of behaviours, for example, is associated with children's display of empathy (Ensor & Hughes, 2005). Through discussing and modeling ER, parents structure the salient emotional elements of distressful events so that their children can understand and organize for themselves strategies for dealing with emotion (Landry, Miller-Loncar, Smith, & Swank, 2002). Exposing children to examples of well-modulated negative emotion contributes to both knowledge about the appropriate ways to express negative emotion and understanding of other people's emotional experiences (Denham, 1998).

Comparison between children's performance on ER tasks and tasks in which they must infer other people's emotions supports the conclusion that affective social understanding is related to ER. For example, Garner and Power (1986) found that children's inferences about other people's emotions were related to their ability to activate positive emotion after receiving a disappointing gift. Carlson and Wang (2007) reported that children's ability to predict a story character's emotion was positively related to saying that they liked a disappointing gift and to parent-report ER, but neither of these correlations remained significant when controlling for age and verbal ability.

Additional research is needed to clarify the relations between affective social understanding, emotion understanding, and ER.

The developmental progression from affective social understanding to cognitive social understanding suggests that early emotional experiences are also important developmental building blocks for later cognitive development. Evidence to support this notion comes from a number of longitudinal studies. Dunn, Brown, Slomkowski, Tesla, and Youngblade (1991) found that children growing up in families that openly discussed emotion (especially the causes of emotion) at 33 months later had better false belief understanding at 40 months than children from less verbal families. Taumoepeau and Ruffman (2006; 2008) found that mothers' talk about desires but not thoughts and knowledge when a child was 15 months of age was an independent predictor of children's cognitive and emotional development at 24 months, whereas at 24 months of age, mothers' reference to others' thoughts and knowledge was the most consistent predictor of children's later mental state language at 33 months. These findings suggest that it is both important to distinguish between cognitive and affective social understanding and that cognitive and affective social understanding have distinct patterns of antecedents and outcomes.

Cognitive social understanding. In contrast to a growing literature examining the relation between affective social understanding and ER, little is known about the links between cognitive social understanding and ER. The only study that has directly addressed this question did not find a relation between false belief understanding and performance in a disappointing gift task (Liebermann et al., 2007). This study, however, used only one cognitive measure of social understanding (i.e., false belief task).

Evidence that social understanding may also include affective aspects of social understanding suggests that additional studies are needed that examine different aspects of social understanding in relation to ER.

The primary reason to suggest that ER and social understanding are linked is that both contribute to flexible self-regulation. Beyond this general association, ER and social understanding also have mutual links to EF. The common association between EF and social understanding, and EF and ER raises questions about the potential linkages between ER and social understanding. Connections between ER and social understanding are also evident in everyday behaviours. For example, regulating emotional expression in response to a disappointing gift requires: (a) an understanding of one's own perspective ("I don't like this gift"), (b) an understanding of the other person's perspective ("My grandmother thinks this is something I would like"), (c) an awareness of the social norms around receiving a gift (you should show appreciation when receiving a gift), and (d) an understanding of how one's behaviour will affect the other's person (saying "thank you" will make grandmother happy but telling her I don't like it will make her sad). Clearly, adaptive and flexible ER in response to a disappointing gift requires social understanding – although other abilities, such as inhibitory control and motivation (i.e., to protect grandmother's feeling) are also required.

To summarize, social understanding is an important but neglected aspect of ER. Most research that examines social understanding in the context of self-regulation has focussed on exploring the relation between cognitive social understanding (i.e., false belief understanding) and EF. Few studies have explored the linkages between social understanding and ER. No studies to date have examined the possibility that both

cognitive and affective aspects of social understanding may be related to ER. The present study addresses this gap.

Contributions of Executive Function and Social Understanding to Emotion Regulation

Until recently, research on the development of EF and social understanding has progressed independently of investigations of emotional development. This is in stark contrast with the spate of work on the relation between EF and social understanding (see Moses & Tahiroglu, in press). Although most definitions of ER suggest that it includes both affective and cognitive processes (Cole et al., 2004; Thompson, 1994), the nature of emotion-cognition interaction remains speculative. Zelazo and Cunningham (2007), for example, have recently proposed an interactive model in which conscious, goal-directed problem solving can be decomposed into emotional and cognitive processes. According to this model, ER and EF bear a reciprocal relation, the nature of which is determined by the emotional salience of the problem. Emotions can help organize one's thinking, learning, and action. However, emotions can also disrupt these processes. When the "target" of problem solving is the emotion itself (e.g., "don't show fear") then ER and EF are isomorphic. In contrast, when modulating emotion is secondary to the problem solving goal (e.g., maintaining a smile in order to facilitate pleasant social interaction), then EF is said to involve ER. This model is just one example of the burgeoning research interest in the developmental transactions between cognitive and emotional regulation processes.

There are several reasons to suspect that EF and social understanding are fundamentally linked with ER in development. First, at the same time as children have great difficulty managing the emotional demands of the problems they encounter, they

also demonstrate poor organization of problem solving and deficits in social understanding (Carlson, 2005; Moses & Carlson, 2004). Furthermore, rapid changes in EF (Zelazo, Müller, Frye, & Marcovitch, 2003), ER (Cole et al., 2004; Eisenberg, Spinrad & Smith, 2004; Kerr & Zelazo, 2004; Kopp, 1989), and social understanding (Wellman et al., 2001) between the ages of 3 and 5 raise questions about the extent to which these processes may be developmentally interdependent.

A second reason to suspect that EF and social understanding are developmentally linked with ER is that rapid improvements in ER, EF, and social understanding during the preschool years are related to maturation of the prefrontal cortex (Bell & Wolfe, 2004; Blair, 2002; Hongwanishkul, Happaney, Lee, & Zelazo, 2005; Zelazo & Müller, 2002). In addition, prefrontal areas known to be important for performance of EF and social understanding are extensively and reciprocally interconnected with brain stem and limbic structures associated with emotional reactivity and regulation (Banfield, Wyland, Macrae, Munte, & Heatherton, 2004; Blair, Zelazo & Greenberg, 2005; Lewis & Todd, 2007). These interconnections suggest that maturation of the prefrontal cortex may support a wide range of self-regulatory functions, including cognitive, emotional, and social regulation.

Third, EF and social understanding may be developmentally linked to ER because advances within one domain may be required for developments in other domains. For example, some aspects of cognitive development may depend on a certain level of emotional organization whereas, in turn, some aspects of emotional development may depend on a certain level of cognitive organization (Blair, 2002). Research with young infants suggests that development of attentional control abilities supports the emergence

of ER (Fox & Calkins, 2003; Morales et al., 2005). In addition, intense emotions can disrupt self-regulation, suggesting that some level of ER may be a prerequisite for the exercise of other forms of self-regulation (Frijda & Mesquita, 1998).

Fourth, a process analysis of self-regulatory behaviour suggests that successful problem solving “in the real world” depends on the flexible integration of social cognition, ER, and EF (Blanchard-Fields, 2007; Gross, 1998). Children who are relatively strong cognitive regulators may nevertheless perform poorly on problem solving tasks if their emotional or social regulation abilities are poor. Baumeister and colleagues (e.g., Baumeister, Zell, & Tice, 2007), for example, have demonstrated that negative emotion undermines inhibitory control and interferes with social information processing. In the disappointing gift task, children who experience negative emotion may find it extremely difficult to inhibit expressing their disappointment, despite their knowledge of the likely (negative) impact of those expressions on the gift giver. These examples support the conclusion that aspects of self-regulation are reciprocally interconnected (Perner & Lang, 1999).

Finally, EF and social understanding may be related to ER because language plays a fundamental role in self-regulation. Vygotsky, for example, viewed language as a “cultural tool” capable of forging the structure of higher psychological functions: “With the aid of speech the child for the first time proves able to be the master of its own behaviour, relating to itself as to another being, regarding itself as an object. Speech helps the child to master this object through the preliminary organization and planning of its own acts of behaviour” (Vygotsky & Luria, 1994, p. 11). According to Zelazo and colleagues (Zelazo, 1999; Müller, Jaques, Brocki, & Zelazo, in press), language has both

constitutive and executive functions in the development of self-regulation. The *constitutive* function of language creates a mental “space” in which conscious self-reflection creates psychological distance between the child and the world. Language, among other things, mediates between direct experience and action so that deferred action becomes possible. Through language, the world of moment-to-moment stimulation is decoupled from the world of possible action resulting in opportunities for recursive consciousness – consciousness of internal and external stimulation that is not present in the moment. The *executive* function of language transforms the conscious use of language into self-directed speech that allows children to exercise control over their thoughts, actions and emotions. The executive function of language may contribute to the exercise of ER by creating self-instruction about the control of emotion. For example, once a child becomes aware of an emotion (through the constitutive function of language), she can then reason about the emotion provoking situation, and this reasoning functions as a tool for constructing response alternatives which replace the expression of the initial emotion.

Based upon the proposal that language functions contribute to the emergence of metacognition, one might also expect language functions to facilitate the development of ER. Language provides children with the tools to become aware of, express, and modulate their emotional experiences. Kopp (1992), for example, suggested that one of the reasons for a developmental decrease in crying in the third year and following is the emergence of new language abilities. Young children who had poor language production ability were found to cry more often during home or laboratory visits than children with better language ability. Language may also facilitate the development of inhibitory

control, and inhibitory control may in turn facilitate ER. In a study of delay of gratification in young children, Vaughn, Kopp, and Krakow (1984) found that language abilities were related to inhibitory control even after controlling for the effects of age. More direct evidence of the link between language and ER comes from studies of children with language impairments. Compared to typically developing children, children with selective language impairment show deficits in the ability to up-regulate emotional arousal necessary for social interaction (Fujiki, Spackman, Brinton, & Hall, 2004). Together, these findings suggest that language is related to and probably necessary for the development of ER.

To summarize, there is evidence to suggest that: (a) processes of emotional activation and regulation are separate but interdependent; (b) ER, EF, and social understanding undergo dramatic development in the preschool period; (c) these improvements in ER, EF and social understanding draw on common neural substrates; (d) ER, EF, and social understanding are developmentally interdependent; (e) successful self-regulation requires a flexible organization of ER, EF, and social understanding; and (f) ER, EF, and social understanding are related to language abilities. Previous research examining relations among different aspects of self-regulation has focussed either on the EF-social understanding relation or on the EF-ER relation. There is a need for research examining the contribution of different aspects of EF and social understanding to the development of ER. In addition, previous research has not considered how language and temperament might influence the contribution of EF and social understanding to ER. The present study was designed to evaluate the unique contributions of EF and social understanding to ER after removing the effects of language and temperament. In

addition, this study addresses the need for research that considers how developments in ER, EF, and social understanding might be related to common problems in self-regulation, such as temper tantrums. Rapid declines in temper tantrums during the preschool period suggest that changes in children's temper tantrums may be related to developmental gains in ER, EF, and social understanding. In the next section, I briefly review the existing research on temper tantrums in relation to emotional reactivity, ER, EF, social understanding, and language.

Temper Tantrums

Despite their nearly ubiquitous manifestation in early childhood, little is known about the nature and significance of temper tantrums. Temper tantrums are brief but intense emotional episodes that are characterized by explosive, impulsive, out-of-control, whole body displays of anger (M. Potegal, personal communication, May 30, 2007). Children may be functioning well one moment and "fall apart" the next. Early work by Goodenough (1931) and Macfarlane (1938; Macfarlane, Allen, & Honzik, 1954) remains the most complete descriptions of temper tantrums in young children. Based on these influential studies, several conclusions about the development of temper tantrums can be drawn. First, tantrums tend to increase in frequency between the first and third birthdays. Thereafter they tend to fall off sharply. Second, the nature of tantrums changes with age. Early tantrums tend to be poorly organized, diffuse, and vague with regard to their goals. With increasing age, children's tantrum behaviours display more coherence with regard to both the constellation of behaviours involved and their relation to the desired end. Third, there is a trend toward the increased symbolization of tantrum behaviours. With age comes a transfer of action toward the symbolic realm and away from physical action.

For example, children substitute verbal aggression for physical aggression. Fourth, direct confrontation of the person or object blocking the child's goal becomes more likely with age. Older children are much more likely to retaliate against those persons or objects that are responsible for their frustration. However, in keeping with developments in language abilities, older children tend to retaliate in ways that hurt other's feeling rather than injure their bodies. Finally, the severity of tantrums during developmentally normal periods has little prognostic relevance for children's eventual academic and social success (Kagan & Moss, 1983). However, patterns of poor emotional control that persist into late childhood portend significant educational, occupational, and marital difficulties in adulthood (Caspi, Elder, & Bem, 1987).

These general conclusions about temper tantrums provide a strong basis on which to suggest that temper tantrums and self-regulation are fundamentally linked in development. First, the developmental trajectories for improvements in self-regulation and declines in temper tantrums are temporally linked. Surprisingly, no research to date has examined the possibility that improvements in self-regulatory abilities are related to declines in temper tantrums. Early work by Goodenough (1931) and more recent work by Potegal and colleagues (Potegal & Davidson, 2003; Potegal, Kosorok, & Davidson, 2003) suggest that changes in temper tantrums (e.g., the increased symbolization of angry and aggressive behaviours) may be related to changes in higher-order cognitive processes. Second, young children's relatively disorganized and inefficient problem solving abilities may contribute to the frustration they feel when their goals are blocked. For example, children who have difficulty shifting focus from one aspect of a problem to the next may be unable to recognize response alternatives that could reduce their

frustration. There is considerable development in children's abilities to construct plans in advance of action during the preschool years, although preschoolers often experience difficulty implementing their plans (Hudson, Soso, & Shapiro, 1997). Goal directed behaviour may be especially vulnerable to disruption by negative emotion, particularly among children who display high levels of emotional reactivity and low levels of ER (Perez & Gauvin, 2005). Third, whether through habit of practice or by fundamental response biases built into the very function of emotion (LeDoux, 1995; Ohmen, 2002), temper tantrums may come to represent a prepotent emotional response to a blocked goal. Children may require considerable skills related to attentional shifting, inhibitory control, planning, and social understanding before new patterns for tolerating frustration can emerge.

Beyond specific developmental links between temper tantrums and aspects of self-regulation, patterns of tantrum expression in young children may also depend on more fundamental characteristics of child development. In particular, the cessation of temper tantrums may be related to declines in temperamental reactivity and improvements in language ability. Longitudinal trajectories of externalizing behaviour, for example, decline during the preschool years, but this effect is moderated by negative emotionality – high negative emotionality is related to stable patterns of externalizing behaviour while low negative emotionality is related to declining externalizing behaviour (Gilliom & Shaw, 2004). In addition, language may play a fundamental role in the developmental declines in temper tantrums because children can use language to express and distance themselves from their frustration. For these reasons, it is important to

include measures of temperament and language alongside measures of self-regulation and temper tantrums.

Goals of the Present Study

The purpose of the present study was to examine the nature and strength of the relations between ER and other aspects of self-regulation, including EF and social understanding, and to explore their influence on temper tantrums by using a wider range of measures than did previous studies. The current study was designed to extend current understanding in two ways: first, to examine the contribution of different kinds of EF and social understanding to ER, and second, to examine temper tantrums as an ecologically valid and developmentally salient marker of ER.

To examine the contribution of different aspects of self-regulation to understanding ER, a cross-sectional, multimethod, multitrait design was adopted here. Multiple converging measures of ER, EF and social understanding were administered using well established laboratory measures and standardized questionnaires. Additionally, measures of emotional reactivity and verbal ability were included as control variables to determine whether observed relations reflect unique associations among constructs. Finally, exploratory measures of temper tantrums were included to examine the relation between self-regulation and temper tantrums.

Precautions were taken to reduce the unavoidable overlap between measures of ER, emotional reactivity, and temper tantrums. Although measures of ER, emotional reactivity, and temper tantrums were based on similar behaviours an attempt was made to sharpen the difference between them. This was accomplished by choosing measures that had very little procedural or content overlap. For example, parent-report measures of ER

were based primarily on parental knowledge of the child's regulatory abilities within very specific situations while ratings of emotional reactivity were based more broadly on parent's perceptions of the child's general emotional responsiveness. In contrast, parental temper tantrum ratings were based on specific behaviours exhibited during previously observed temper tantrums.

This study builds upon previous research that has demonstrated links between ER and inhibitory control. Rather than focusing on one aspect of EF, as had been done in previous studies, this study included a battery of EF tasks measuring updating/working memory, shifting, and inhibitory control. Studies examining different aspects of EF are needed to clarify which specific processes are included in the relation between EF and ER. Based on previous studies that had examined the relation between ER and EF, and findings from studies providing indirect evidence of this relation, I expected that updating/working memory, shifting, and inhibitory control would be related to measures of ER. In addition, I expected that inhibitory control would be uniquely related to ER, even after accounting for other aspects of EF.

This study also extends previous research by examining the relation between ER and different aspects of social understanding. Previous research examining this relation had focussed on the cognitive aspect of social understanding (i.e., false belief understanding). Accordingly, a measure of affective social understanding was included with the expectation that affective social understanding would be more closely related to ER than cognitive social understanding.

The first goal of this research, then, was to examine the contribution of different aspects of EF and social understanding to ER. In order to strengthen inferences about the

unique contributions of EF and social understanding to ER, verbal ability and negative reactivity were also assessed as covariates. The first hypothesis was that individual differences in different aspects of EF and social understanding would contribute to individual differences in ER after controlling for emotional reactivity and verbal ability.

The second goal of this study was to examine the nature and strength of relations between different aspects of self-regulation and temper tantrums. In particular, the role of ER was seen as important for understanding individual differences in temper tantrums over the preschool years. Based on the assumption that young children's limited language abilities contribute to frustrations that result in temper tantrums, I expected that children's temper tantrums would also be related to their verbal abilities. Accordingly, the second hypothesis was that individual differences in ER would contribute to individual differences in temper tantrums after controlling for EF, social understanding, negative reactivity, and verbal ability.

Finally, and in support of the second goal of this research, the role of ER in the relation between emotional reactivity and temper tantrums was examined. I expected that negative emotional reactivity would be related to temper tantrums and that the effect of negative reactivity on temper tantrums would be influenced by children's ER. Furthermore, given that temper tantrums have been shown to decline with age, I expected that the frequency and intensity of temper tantrums would be related to age. Accordingly, the final hypothesis was that individual differences in ER would mediate the relation between negative reactivity and temper tantrums, even after controlling for age.

To summarize, this study examined the contribution of EF and social understanding to ER and the contributions of ER, EF, and social understanding to temper tantrums in 3-5-year-old children. ER, EF, and social understanding are considered key aspects of developing self-regulatory competencies in children but the relation between them in child development has yet to be specified. Examining the developmental relations among these aspects of self-regulation has the potential to shed light on our understanding ER and how it may be related to other aspects of self-regulation and to common behaviour problems in everyday contexts, such as temper tantrums. Verbal ability and emotional reactivity were included as control variables to strengthen the assessment of unique relations among these constructs.

Methods

Participants

This study was part of a larger study on self-regulation and school readiness. Families with children between the ages of 3 and 5 were recruited through both daycares (i.e., contacting daycare providers) and community advertisement (i.e., kidsinvictoria.com and Island Parent magazine) for participation in a study of the relation between self-regulation and school readiness. Approximately 60 parents, who had seen advertisements, made inquiries about the study; 22 (37%) of these families were eligible (i.e., child was between 3 and 5 years, child with no major developmental delay) and agreed to participate. All parents of children ages 3 to 5 within four daycares centres were also invited to participate. Of the 117 consent forms sent out through these daycares, 111 (95%) were returned. In total, 133 parents agreed to participate. Of the 133 children enrolled in the study, two did not agree to be tested when they were invited to participate, two were dropped of concerns about major developmental delays, and two others were dropped because of refusal to complete many of the tasks³. The final sample of 127 children had an age range of 36.0 through 68.2 months with a mean age of 50.5 months. Sixty one percent of the children ($n = 77$) were male. Eighty three percent of the participants ($n = 106$) were tested in daycares.

Although comprehensive SES data were not collected, the social context of the participants can be characterized as middle class. The majority of children ($n = 113$) came from 2 parent families, with 2 or more children ($n = 97$). Approximately half of the sample had an older sibling ($n = 55$) and just under half had a younger sibling ($n = 51$).

³ Dropping children who refuse to participate is problematic in the sense that refusing to participate is likely related to the substantive questions of this research. This issue is addressed more fully in the results section.

The median education level for both the parent completing the questionnaires and the child's other parent was a 4-year university degree. Only 7% of parents completing the questionnaire, and 23% of the child's other parent, had no college or university training. Parents completing the questionnaire reported an average of 8.1 hours per day ($SD = 3.17$) interacting with the child of interest in this study and 4.7 hours per day ($SD = 2.57$) for the child's other parent.

Procedures

Children recruited through daycares were tested in the daycares while children recruited through community advertisements were tested in a child-friendly room (i.e., couches, small chairs and table, etc.) at the University of Victoria. Consent for participation was obtained from parents prior to assessment. In addition, children were informed that their parents had given permission for them to participate and were asked if they would like to "play some games" with the experimenter. Children who agreed were told that they were free to discontinue at any time.

Incentives of \$25 were offered to parents for bringing their children to the university and for completing the parent questionnaire and \$15 for parents with children in daycare for completing the parent questionnaire. Return rate for the parent questionnaire was 100%. In addition, daycares received \$300 for facilitating the implementation of data collection on their premises. Children also received several small gifts (i.e., Hot Wheels car, stickers, pencils, etc.) as part of several tasks (see procedures below).

All testing sessions were videotaped for offline scoring. Two male experimenters tested all of the children. Pilot testing of the tasks indicated that

approximately 60 – 90 minutes were required to complete the entire battery. The tasks were therefore divided into two approximately equal sessions. Children in daycares completed the two sessions on separate days (not separated by more than 2 weeks) while children tested at the university completed the two sessions on the same day but with a break between them. The order in which children completed the two sessions was randomly assigned.

The composition of tasks for the two sessions was based primarily on convenience. Session A was comprised of non-computerized tasks while Session B was primarily computerized tasks (see below for a detailed description of each task). The order of tasks in Session A was Emotion Coping, Backward Digit Span, Backward Word Span, the two Unexpected Location tasks, Dimensional Change Card Sorting (DCCS), Real-Apparent Emotion, Peabody Picture Vocabulary Test (PPVT), and Gift Delay. The order of tasks for Session B was Self-Ordered Search, Preschool Continuous Performance Test, Boy/Girl Stroop, Go/nogo, Tower of Hanoi, Bracken School Readiness Assessment, and Disappointing Gift (results of the Self-Ordered Search, Tower of Hanoi, Boy/Girl Stroop, and Bracken are not reported here). Each session ended with an emotion regulation task (Gift Delay for Session A and Disappointing Gift for Session B) to ensure that any emotion aroused by the task would not interfere with the other tasks and because the tasks resulted in the child having a gift to take home. To make testing more convenient, one of the male testers administered session A to children and a second male tester administered Session B. The order in which the tasks were administered within

each session was the same for all children, as is appropriate for individual differences designs (Carlson & Moses, 2001).⁴

Child Measures

Emotion Regulation

Disappointing Gift. Procedures for this disappointing gift task were based on Carlson and Wang (2007). The experimenter presented the child with an attractively wrapped gift and encouraged the child to open it right away. As the experimenter handed the gift to the child (a plain brown wood chip), he exclaimed that the gift was “really cool!” and that he thought the child was “really going to like it!” The experimenter then turned and busied himself with writing on a piece of paper. Once the child had opened the gift, the experimenter asked, “Isn’t it cool? Do you like your present?” During the next 15 seconds, the experimenter remained focussed on the writing task and then pretended to realize that he had given the child the wrong gift by mistake. The mistake was corrected by giving the child a desirable gift (e.g., stickers). Children’s responses were video recorded for offline coding.

Coding was based on Carlson and Wang (2007). Previous research has shown that positive and negative expressions in the disappointing gift task are independent (Liebermann et al., 2007). Coders recorded the presence or absence of both positive and negative facial display, and the overall intensity of the facial expressions. The presence

⁴ Carlson & Moses (2001) point out that it is advisable to counterbalance order when drawing inferences about means because the effects of order are assumed to cancel each other out when collapsed across different orders. The same is not true when drawing inferences from correlations because the correlations within each order do not fully constrain the overall correlation that results when collapsing across orders. The nature of the correlation will depend on the within order scatter plot and their locations with respect to each other (i.e., the variable means within each order). Further, comparisons between individuals in multidimensional space requires that individuals are exposed to the exact same stimuli, including the order in which they are presented. The resulting correlations may be influenced by the order in which the stimuli are presented, however this is only problematic if the absolute values of the correlations are critical to the investigation.

or absence of both positive and negative verbalizations was also coded. Finally, children's response to the question about liking the gift was recorded. Both verbal and nonverbal responses to the question were accepted. In addition, coders evaluated the tone of the child's response to liking (positive or negative). The two items relating to the question of liking were then combined so that children who said they liked the gift and did so with a positive (convincing) tone of voice were given a score of 0, children who indicated liking of the gift but did so with a negative (unconvincing) tone of voice were given a score of 1, and children who did not respond or who said they did not like the gift were given a score of 2. Indicators of positive emotion were combined to create a positivity composite and negative emotion items were combined to form a negativity composite. Higher scores on the negativity composite indicated less emotion regulation while higher scores on the positivity composite indicated better ER.

Emotion Coping. This measure was a self-report adaptation of the adult-report Children's Coping Scales (described below). In this task, children heard three short vignettes (with accompanying pictures to increase interest in the task) and were asked to indicate which, if any, of four coping strategies would help them feel better if they were in a similar situation. The three vignettes were adapted from the parent-report version so that both parents and children provided ratings of coping based on the same situations. The vignettes included: (a) a social exclusion situation, in which a peer group refuses to play with a target child, (b) a peer rejection situation, in which a child is being made fun of by peers, and (c) a peer aggression situation in which a child's sand castle is destroyed by a peer.

To simplify the task, children were first shown a card depicting facial expressions of five emotions: sad, angry, happy, fearful, and alright or OK. Children who made misidentifications were corrected before the task proceeded so that all children could correctly match a face to each emotion.

The vignettes were introduced by announcing; “Now we are going to play a pretend game. I’m going to show you some pictures and tell you some stories and I want you to pretend that the pictures and stories are about you.” A vignette was randomly chosen and the picture corresponding to this vignette was displayed. For example, for the social exclusion vignette the experimenter displayed a picture of several children playing with a ball and a single child spatially separated from the playing children. While pointing to the excluded child, the experimenter said, “Pretend this is a picture of you on the playground. The other children have started a game and won’t let you play with them.” Children were first asked, “How would you feel if that happened?” The card depicting the 5 emotion faces was presented to children to aid them in answering this question. Children were allowed to answer verbally or by pointing. They were then asked to describe, “What would help you feel better when they won’t let you play the game?” Children’s responses were recorded verbatim (data from this question are not reported here). Regardless of their answer to this open ended question, children were asked a series of follow-up questions about the usefulness of two positive and two negative strategies for helping them feel better. For example, one negative strategy was “Would you feel better if you yelled at the other children?” and a positive strategy was “Would you feel better if you asked the teacher for help?” These were forced choice questions for which children answered “yes” or “no”.

The drawings accompanying the vignettes were designed to be gender neutral thus allowing use of the same drawings with both male and female participants.⁵ In addition, facial expressions and body language of the target child (i.e., the excluded child in the social exclusion vignette) were ambiguous to prevent children from answering the questions based on cues provided in the drawings.⁶ Children received separate scores for positive and negative coping for each vignette. Scores were aggregated across the three vignettes to produce measures of positive and negative coping. Higher scores reflected children's endorsement of more strategies consonant with positive or negative coping.

Emotional Reactivity

Gift Delay. Procedures for this frustration task were modified from Grolnick et al. (1996). The experimenter placed a brightly wrapped present (e.g., a Hot Wheels toy) on the table in front of the child, saying to the child, "This is a present for you, but I have a little bit of work that I have to do, so I want you to wait until I'm done my work before opening it. I'm just going to do a little bit of work and then you can open the gift, OK?" The experimenter then busied himself with writing on a piece of paper. After 3 minutes, the experimenter told the child, "I'm all done with my work, so you can go ahead and open the gift." Children's emotional expressions were coded offline based on the Facial Expression Coding System (FACES; Kring & Sloan, 1991).

FACES is a reliable and valid measure of facial expressive behaviour (Kring & Sloan, 2007). Unlike its more elaborate predecessors (i.e., the Facial Action Coding System; Ekman & Friesen, 1978), FACES does not require identifying specific emotions but rather the valence (i.e., positive or negative) and dynamical qualities of emotion (i.e.,

⁵ No children spontaneously objected to the labeling of the target child as either a girl or a boy.

⁶ No children spontaneously commented on the emotional properties of the pictures.

duration and intensity). A facial expression was defined as either (a) a change in neutral display to a non-neutral display, or (b) a change from one non-neutral display to another non-neutral display. Once an expression was detected, it was coded in four ways. First, coders evaluated its valence: positive or negative. Judgements about valence were ultimately based upon coders' intuitive knowledge about emotion; however, training exercises accompanying Ekman and Friesen's coding manual were helpful in orienting coders to relevant facial changes. Second, coders made a judgement about the intensity of each facial display. Third, coders recorded non-facial evidence of emotion, such as sighing and making negative comments about waiting. Finally, coders made global judgements about the overall facial expressiveness and the overall positivity and negativity of the child during the task as a whole.

The coding scheme used here differs from FACES in several ways. First, duration of expressions was not recorded. This modification was based primarily on the limitations of the available software for viewing the video segments. The timing device in the playback software was not sensitive enough to accurately detail the duration of brief events (i.e., 1 second or less). Second, the scaling of the intensity measure was modified from FACES because children never display emotions that would be rated at the high end of the scale during this task, and therefore the FACES scaling would have resulted in a truncated range of scores. In other words, we reduced the intensity required to achieve the highest end of the scale. Third, we also recorded non-facial expressions of emotion. The frequency of positive and negative verbalizations was recorded along with other indications of positivity and negativity, such as sighing and giggling. Finally, children were given overall ratings of positivity and negativity that were based on their

facial display, their non-facial expressions of emotion, and the overall impression of their behaviour during the entire 3 minute segment. Similar global judgements are made when following the FACES coding scheme but information about non-facial expressions is not included in FACES. Non-facial emotional indicators were included here because they provide additional information about children's emotional reactivity.

Executive Function

The EF battery consisted of six tasks designed to measure multiple aspects of EF.

Dimensional Change Card Sorting (DCCS). Procedures for administering the DCCS followed Hongwanishkul et al. (2005). In this task, children were required to sort cards that differed along two dimensions: colour and shape. Materials consisted of two different types of sorting card (blue rabbits and red boats) and two sorting trays with a red rabbit affixed to one and a blue boat affixed to the other. (Note that children never sorted cards that were identical to the cards affixed to the sorting tray – sorting cards always differed from the sorting tray cards by either colour or shape). The task began with the experimenter identifying the two dimensions of the cards (i.e., shape and colour) by pointing to the cards that had been affixed above the two sorting trays and saying, “Look. Here is a red rabbit and here is a blue boat.” Next, the experimenter randomly chose either colour or shape as the first sorting rule and explained the rules for playing this *preswitch phase*. For example, children who sorted by colour during the preswitch were told, “We are going to play a colour game. In the colour game, if it's red put it here” (pointing to the tray below the red rabbit) “but if it's blue put it there” (pointing to the tray beneath the blue boat). The experimenter then demonstrated the sorting procedure by sorting one card facedown into the appropriate tray. A second card was sorted in this

manner, but this time children were asked to place the card on the appropriate tray. The experimenter provided corrective feedback as needed. This was followed by six preswitch trials in which the experimenter randomly selected a test card (with the constraint that the same type of card could not be presented on more than two consecutive trials), labelled the card by the relevant dimension only (e.g., during the colour game the experimenter would say “here is a blue one”), and then asked participants, “Where does this go?”. Children were required to place the card facedown in one of the trays. No feedback was provided.

After completing six trials, children were told, “Now we are going to play a new game. We are not playing the colour game (for example) anymore. Now we are going to play the shape game.” The rules for the *postswitch phase* were the same as preswitch in every respect except the dimension that was relevant. Accordingly, children were told “In the shape game, if it’s a boat put it here” (experimenter pointing to the boat affixed to the sorting tray), “but if it’s a rabbit put it here” (experimenter pointing to the rabbit affixed to the sorting tray). Six postswitch trials were administered.

Children who passed the postswitch phase (viz. correctly sorted at least 5 of the 6 cards) were given a third, more difficult phase immediately following completion of the postswitch phase. In this *border phase*, children were shown two test cards like those used in the pre- and postswitch and two new test cards that had a ¼ inch black border framing the image of the blue rabbit or red boat. Children were told that the presence or absence of a black border indicated which sorting rule was relevant for that particular card (e.g., “If there’s a black border, you have to play the shape game; if there is no black border, you have to play the colour game”). On each of 6 test trials that followed, the

experimenter stated the rule, randomly selected a test card, (with the constraint that the same type of card could not be presented on more than two consecutive trials), labelled the card by the relevant dimension (i.e., “This one has a border” or “This one has no border”), and then asked children, “Where does this go?” As with the previous phases, no feedback was provided. The total number of correctly sorted cards was calculated for the three phases combined.

Preschool Continuous Performance Test. The Farm Animals Game (Kerns & McInerney, 2007) is a computerized continuous performance task (based on Kerns & Rondeau, 1998) that measures attentional control in preschoolers. Children were first introduced to pictures and sounds of common farm animals (horse, cow, pig, chicken, dog, cat, duck, frog, and sheep). Corrective feedback was given to children who misidentified animals. Children were invited to play a “farm animals game” in which their job was to “feed the sheep,” by pressing the spacebar each time a sheep appeared on the screen. To help children engage in this task, the storyline was elaborated. Children were told that the farmer fed all the other animals but somehow the sheep had been neglected. Since the sheep were hungry, participants could feed them a bit of grass by pressing the spacebar. Children were instructed to avoid pressing the spacebar when other animals appeared because they were no longer hungry. Before proceeding, children’s understanding of the rules was assessed by asking them when they should and should not press the spacebar. Corrective feedback was provided as necessary.

During the task, children simultaneously heard and saw the animals presented in a pseudorandom order on a 30.5 X 35.6 centimetre screen. Visual displays remained on the screen for approximately 1.5 seconds and sounds lasted approximately .75 seconds.

The task lasted five minutes with 200 stimulus presentations of which 29 were targets (i.e., sheep). Children were encouraged to “keep feeding the sheep” as often as was necessary to help them continue the task. The total number of commission errors was used as a measure of inhibition. Higher scores indicated poor inhibitory control.

Go/nogo task. This computerized go/nogo task, designed by Kerns and McInerney (2007) (modeled after Archibald & Kerns, 1999), was composed of four blocks. In the initial block children were asked to press a button as quickly as possible every time they saw a dog “because every time you press the button you scratch the dog’s ears, and he really likes that”. Twenty five dogs were flashed, one per second, in pseudorandom locations on a 30.5 X 35.6 centimetre screen. This first block was used to develop a response habit (i.e., a prepotent response) to dogs (the “nontarget” stimulus). The second block consisted of 25 trials, in which the child was asked to press the button as quickly as possible to a Koala bear (“because every time you press the button you scratch the Koala’s tummy and he really likes that”) but not to the dogs. Dogs and Koala bears appeared in pseudorandom order and in pseudorandom locations. The third and fourth blocks consisted of 25 trials each in which the child was asked to respond to dogs (3rd block) and then Koala bears (4th block). Prior to starting each block, the experimenter ensured that the child could identify the target stimulus. Scoring was based on the number of commission errors (i.e., responding to a “no go” stimulus). Higher scores indicated poor inhibitory control.

Gift Delay. Procedures for administering this task are described above. Coding procedures for delay inhibition were based on Gilliom et al. (2002). Video recordings of the entire 3 minute gift delay tasks were coded on a second-by-second basis for children’s

delay inhibition. Coding of delay inhibition was performed separately from the previously reported emotional reactivity coding based on this same task. Coders recorded the duration of activities suggesting attention toward the gift (i.e., looking at, touching, and talking about the gift) as well as the latency to first touch and latency to first peek. Proportion scores were calculated to deal with the fact that sessions did not always last 180 seconds. For ease of interpretability, scores were reversed so that higher scores indicated better delay inhibition.

Backward Digit Span. Following Davis and Pratt (1996), participants were asked to repeat a series of single-digit numbers backwards. To engage children in this task, the experimenter told them that a puppet named Molly would like to play a silly backward game with them. Children observed as Molly “said” a series of digits and then the experimenter demonstrated how to repeat them in the reverse order, emphasizing that, “in this game when Molly says something, we have to say it backwards”. A 2-digit practice trial was administered, in which participants received corrective feedback as needed. The task was discontinued if the participant was not successful after two repetitions of the practice trials. Children received two trials at each of 2-, 3-, and 4-digit lengths. The task was discontinued when children failed both trials of the same length (i.e., both of the 3-digit trials). The total number of trials passed was recorded for analysis. Higher scores indicated better performance.

Backward Word Span. The procedures for this task were identical to those of the Backward Digit Span, with the only difference that digits were replaced with single-syllable, non-semantically related words (see Carlson, Moses & Breton, 2002). The total

number of trials passed was recorded for analysis. Higher scores indicated better performance.

Social Understanding

Cognitive social understanding. Children's cognitive social understanding was assessed using two location false belief tasks modeled on the classic task by Wimmer and Perner (1983). In one task, two dog puppets (Scruffy and Wiggles) briefly played with a bone before Wiggles placed the bone in either a blue or purple container. Wiggles left to "play outside" and Scruffy retrieved the bone, played with it briefly, and then put it in the opposite container from the one in which Wiggles had hidden it. Finally, Wiggles returned and declared that he was hungry and wanted to eat his bone. Children were first asked the false belief question, "Where will Wiggles look for his bone?" followed by the reality control question, "Where is the bone really?", and finally, the memory control question, "Where was the bone first of all?". A second location false belief task was administered in exactly the same manner but with different puppets (a monkey and giraffe) and a cookie rather than a bone. Children received credit for passing the task only if they correctly answered the false belief, reality, and memory questions. Total score on this task was the number of items passed (range 0 – 2). Higher scores indicated better cognitive social understanding.

Affective social understanding. This task, adapted from Harris et al. (1986), was used to measure children's ability to distinguish between real and apparent emotions. Children heard two short vignettes, one positive and one negative, about situations that would likely provoke emotion in real life. For boys, the stories concerned a protagonist named David and, for girls they concerned a protagonist named Diana. First, participants

reviewed drawings of happy, sad, and neutral faces on a card that had been presented during the Emotion Coping task. They were asked to point to the appropriate faces for “happy”, “sad”, and “just OK”. Children were corrected if they misidentified the faces. As a further check on their ability to infer emotions from everyday situations, children were asked to indicate how David/Diana would feel if “it was her/his birthday,” “if s/he fell of his/her bike and hurt himself/herself,” and “if there was nothing special happening, nothing bad and nothing good.” After ensuring that children were familiar with these emotions and could use them to make inferences about how children would feel in different situations, the facial drawings were set aside. This was done to prevent any possible interference between the pictorial display of emotion and the emotion inferred from the vignette.

For each vignette, the experimenter told the story and then asked two memory questions that drew the child’s attention to aspects of the story pertaining to the protagonist’s real and apparent emotion. These were followed by the target questions asking how the protagonist really felt inside and what emotion s/he actually displayed. For example, for the negative emotion vignette, girls were told that “Diana wants to go to her friend’s birthday party but she has a tummy ache. She knows that if she tells her mom that she has a tummy ache, her mom will say that she can’t go to the birthday party. So, she tries to hide the way she feels so that her mom will let her go to the party.” Memory questions were asked first (“What was the matter with Diana?,” and “What will Diana’s mom say if she knows that Diana has a tummy ache?”), followed by the real emotion question (“How did Diana really feel when she had a tummy ache?”) and the apparent emotion question (“How did Diana try to look on her face when she had a

tummy ache?). The order in which children heard the real and apparent emotion questions was counterbalanced so that half the participants first heard the question about the protagonist's apparent emotion. Positive and negative stories were also counterbalanced so that half the participants heard a positive story first.

Following the coding scheme of Harris et al. (1986) children were scored as pass or fail. In order to pass, children were required to satisfy two criteria: (a) to answer both memory questions correctly, and (b) to recognize the difference between the real and apparent emotions. For the negative vignette (see example above), children received a passing score if their answer to the real emotion question was more negative than their answer to the apparent emotion question (i.e., that Diana's tummy would feel worse than her face would indicate). Conversely, in the positive vignette, children were required to judge that the protagonist would feel more positive emotion than she would display (i.e., that Diana would feel more positive about winning than her face would show). Total score on this task was the number of items passed (range 0 – 2). Higher scores indicated better affective social understanding.

Vocabulary

Peabody Picture Vocabulary Test (PPVT-III). The PPVT-III (Dunn & Dunn, 1997) is a widely used measure of receptive vocabulary. The materials consist of a booklet containing 4 pictures on each page. For each page, children heard a word read aloud (e.g., banana) and were asked to point to the picture on the page that corresponded to the word. Two practice trials were administered and corrective feedback was given as needed to ensure that children understood the task. The task discontinued when children

make an error on 8 out of a set of 12 words. Raw scores (ceiling item – number of errors) were used in data analysis. Higher scores indicated better verbal ability.

Parent Report Measures

Emotion Regulation

Children's Coping Scales. This measure, adapted from Eisenberg et al. (1993), was a parent report measure of child coping in three emotionally relevant situations. Parents read a short vignette about a child being excluded from a peer group, being made fun of, or having a block tower destroyed by another child. Using a 5-point Likert-type scale, parents rated the extent to which their children were likely to use each of 9 different coping strategies: (a) instrumental coping (takes some constructive action to improve a problem situation), (b) emotional intervention (cries to elicit assistance from others to help solve the problem), (c) instrumental aggression (resolves problems through physical or verbal aggression), (d) avoidance (leaves or avoids a problem situation), (e) distraction (keeps him- or herself busy so as not to think about the problem), (f) venting (cries to release pent-up feelings or elicit comfort from others), (g) emotional aggression (uses physical or verbal aggression to release pent-up feelings), (h) cognitive restructuring (tries to think about the situation in a positive way), and (i) emotional support (talks about his or her problems with friends or a teacher in hope of getting support). The authors report high internal consistency for each of the nine coping strategies across the three vignettes (α s = .88 to .98). Scores for each of the nine coping strategies were aggregated and averaged across the three vignettes.

The Emotion Questionnaire-ER scales. The Emotion Questionnaire (Rydell, Berlin, & Bohlin, 2003) is a parent-report questionnaire that includes measures of

emotional reactivity (described later) and ER. Items on the ER scales ask parents to provide both global ratings of regulatory competence as well as ratings of regulation in specific situations. The ER scales include items relating to the regulation of fear, sadness, anger, and happiness/excitement. For present purposes, however, only the 20 items relating to the regulation of anger and sadness were administered. The authors report internal consistency for anger ($\alpha = .79$; Rydell, Berlin, & Bohlin, 2003) and sadness ($\alpha = .76$; Rydell, Thorell, & Bohlin, 2004) that are adequate. Stability of the regulation measures over 5 weeks was reported to be between .74 and .79 (Rydell et al., 2003). Children received separate scores for anger and sadness regulation. Higher scores indicated better ER.

Emotional Reactivity

The Children's Behavior Questionnaire. The Children's Behavior Questionnaire short version (CBQ) (Putnam & Rothbart, 2006) is a shortened version of the widely used standard CBQ (Rothbart, Ahadi, Hershey, & Fisher, 2001). It contains 94 Likert-scale items (from *extremely untrue of your child* to *extremely true of your child*) comprising 15 subscales. Of primary interest for present purposes was the negative affectivity factor from the CBQ, which measures individual differences in the tendency to become negatively aroused in a variety of challenging circumstances. Items from the anger/frustration ($n = 6$), sadness ($n = 7$), and soothability ($n = 6$) scales were administered for this purpose. The reliability of the CBQ is well supported (Putnam & Rothbart, 2006). Items on the three scales were combined (soothability was reverse scored) to generate a mean estimate of negative affectivity. Higher scores indicated greater negative affectivity.

The Emotion Questionnaire-negative emotionality. In addition to measuring emotion regulation (see above) the Emotion Questionnaire contains scales that measure the frequency and intensity of negative emotional responding. Items asked parents to provide both global and specific ratings of negative emotionality in specific situations. For present purposes, only the scales relating to the characteristic tendency for children to activate anger ($n = 4$) and sadness ($n = 4$) were administered. The authors report internal consistency for anger ($\alpha = .77$; Rydell, Berlin, & Bohlin, 2003) and sadness ($\alpha = .65$; Rydell, Thorell, & Bohlin, 2004) that are adequate. Stability on these two subscales over 5 weeks was reported to be between $r = .62$ and $r = .78$ (Rydell et al., 2003). Items on the anger and sadness scales were combined to generate a mean estimate of negative emotionality.

To generate an overall measure of emotional reactivity, the negative affectivity aggregate from the CBQ and the negative emotionality aggregate from the Emotion Questionnaire were standardized and combined. Higher scores indicated greater negative emotionality.

Temper Tantrums

The Temper Tantrum Grid (modified from Potegal & Davidson, 2003) measures the frequency and intensity of behaviours commonly displayed by children during temper tantrums (see Appendix A). These include: crying, whining, screaming, yelling words, kicking, hitting, stamping, running away, throwing things, and pushing or pulling objects. Temper tantrums were defined as episodes of strong emotion (i.e., facial expression of emotion) in which the child also displayed one or more of these behaviours. Parents were instructed to exclude those times when their child was reacting to injury (e.g., falling off

a bike), reacting in fear (e.g., screaming because of fear of a dog), squabbling with siblings (however, if squabbling turned into a tantrum then they were instructed to include the tantrum), and times when the child was openly defiant (e.g., looking the parent in the eye and disobeying). For each behaviour observed during temper tantrums in the past month, parents rated the frequency on a 5-point scale (ranging from *never* to *all of the time*) and the intensity on a 4-point scale (ranging from *little or none* to *severe*).

Scoring of the Temper Tantrum Grid was based on several considerations. First, it was not reasonable to expect that children would express all 10 behaviours during any particular temper tantrum. Children probably display an individual tantrum style that includes particular behaviours and not others. Over the course of many tantrums, however, it was assumed that children would express a range of common tantrum behaviours, and that children who displayed a greater variety of tantrum behaviours were more severe tantrummers. This assumption was based, in part, on the findings of Potegal et al. (2003) that longer tantrums included a greater variety of tantrum behaviours and those longer tantrums generally indicate more severe tantrums. Second, patterns of tantrums that were frequent but low in intensity likely have a different implication for self-regulation than tantrums that were infrequent but intense. In other words, the frequency and intensity of tantrums interact (i.e., are multiplicative rather than additive) in estimations of severity. Based on the assumption that intensity and frequency have a synergistic effect on tantrum severity and that the display of a variety of behaviours across a number of tantrums is related to greater tantrum severity, frequency and intensity ratings were multiplied and these products were summed across the 10 behaviours to generate a total tantrum score. Higher scores reflected greater tantrum severity.

Table 1 provides a summary of child and parent-report measures for each construct.

Table 1. Summary of child and parent-report measures for study constructs

Construct	Child Measures	Parent-Report
Emotion Regulation	<ol style="list-style-type: none"> 1. Disappointing gift 2. Emotion coping 	<ol style="list-style-type: none"> 3. Children's Coping Scales 4. Emotion Questionnaire
Executive Function	<ol style="list-style-type: none"> 1. Working Memory/Flexibility <ol style="list-style-type: none"> 1. DCCS 2. Backward digit span 3. Backward word span 2. Response Inhibition <ol style="list-style-type: none"> 1. CPT 2. Go/no go 3. Delay Inhibition <ol style="list-style-type: none"> 1. Gift Delay 	
Social Understanding	<ol style="list-style-type: none"> 1. Cognitive Social Understanding <ul style="list-style-type: none"> - Location false belief 2. Affective Social Understanding <ul style="list-style-type: none"> - Real-Apparent emotion 	
Temper Tantrums		Temper Tantrum Grid
Emotional Reactivity	Gift Delay	<ol style="list-style-type: none"> 1. CBQ 2. Emotion Questionnaire
Verbal Ability	PPVT-III	

Results

In the following sections, I first describe the analytic strategies and screening procedures applied to all variables. Then I describe the coherence within individual measures and strategies used to reduce data for the different constructs assessed in this study. Next, I report results from tests of the relations among cognitive, social and emotional aspects of self-regulation. Finally, I describe the relations between temper tantrums and aspects of self-regulation.

General Analytic Considerations

Missing Data

Child measures. Data for child measures were missing for three reasons (see Table 2). One reason was experimenter or equipment failure ($n = 4$). A second reason was related to the difficulty children had with some tasks. In general, the lowest possible score was imputed when children attempted a task but were unable to perform it.⁷ Imputing the lowest score was not possible on the ER Coping task, however, because the response options were categorical.⁸ Finally, data were missing because children refused to complete a task or the experimenter decided to move on without completing a task in order to maintain the child's motivation. This occurred most frequently on the tasks which challenged children's attentional abilities (i.e., CPT, and Go/nogo). Overall, these three categories of missing data represented 4.2% of responses from children.

⁷ Although missing data due to lack of ability to perform the task are indeed missing data, the assumption made here is that inability to perform the task is instructive of the child's underlying ability on that task. Imputing the lowest possible score on the task reflects this assumption.

⁸ The ER Coping task was designed to elicit negative emotion and the response options for this task were predicated on children reporting negative emotion. When children reported positive emotion follow-up questions could not be administered because the questions were related to coping strategies that would help children feel better. Further, it was not possible to simply give them a score of zero on this task because this would have indicated that the child in fact did understand the nature of the task and did not endorse any of the coping strategies as ones that would help them feel better.

Table 2. Frequency of missing data by task and reason (child measures)

Study Variable	Experimenter/ equipment error	Child failed previous item	Child refused or experimenter discontinued to maintain motivation
ER Coping	4	11	0
Cognitive Social Understanding	0	0	1
Affective Social Understanding	0	0	3
PPVT-III	0	0	2
DCCS	0	0	3
Backward WM	0	0	3
CPT	2	0	8
Go/nogo	0	0	7

Given the likelihood that missing values due to refusals were related to the substantive questions examined in this study, children with complete data were likely to be children with better self-regulation. To test this ad hoc hypothesis, a new variable was generated that tallied the number of refusals for each child across all study tasks. Table 3 shows that nearly 10% of the sample had one or more refusals. Correlation analysis revealed that refusals were related to decreased performance on only the PPVT-III $r(125) = -.21, p < .05$. Children with more refusals had lower verbal ability than children with few or no refusals. It is of interest to note that the majority of missing data came from tasks for which there was no verbal requirement. This seems to indicate that verbal

Table 3. Frequency of refusal by individual

Number of Refusals	Frequency	Percent
0	115	90.6
1	4	3.1
2	3	2.4
3	2	1.6
4	1	.8
5	2	1.6

ability was not a direct cause of missing data.

To further explore the influence of refusals on the present analysis, the sample was dichotomized into groups of children with one or more refusal and children with no refusals. T-tests were calculated on all demographic and study variables to determine if there were any group differences between refusers and non-refusers. Because of the exploratory nature of this analysis, no Type 1 error corrections were made. Despite a liberal alpha of .05, groups differed only on verbal ability $t(125) = 2.21, p = .029$.

Although missing values resulting from refusal were related only to verbal ability (which was considered a control variable in this study), and were mostly confined to a small number of children and small proportion of the total data collected, they were nevertheless problematic because: (a) they affected almost 10% of the sample, (b) they were probably related to aspects of self-regulation that were not measured in this study (i.e., motivational aspects of self-regulation), and (c) they were very likely missing, at

least in part, because of the phenomena being measured (i.e., aspects of self-regulation). Thus, these missing data should be considered missing not at random (MNAR), meaning that mechanisms of missingness cannot be ignored in handling the missing data (Acock, 2005; Howell, 2008; Widaman, 2006).⁹ Unfortunately, models for estimating data that are MNAR tend to be complex, unstable, and in practice – even when an approximately correct model for missing data can be specified – performance of these estimation procedures is often poor unless the sample is very large (Schafer & Graham, 2002). Thus, Schafer and Graham advocate using procedures designed for data that are missing at random (MAR) when the violations of assumptions to this approach are not likely to influence results. They point out that although mechanisms of missingness in data that are MNAR are nonignorable, unmeasured and unknown mechanisms would need to be moderately correlated with variables (e.g., correlation of .40 and above) before they are likely to introduce substantial bias to the results. This seems unlikely in all but the most extreme cases. Thus, in many studies, departures from the assumptions of MAR are not likely to be serious. In light of these considerations, and given that good methods for dealing with data that are MAR are available, expectation maximization (EM) was used to impute missing data. The EM algorithm is an iterative procedure that develops initial estimates for missing values that are maximally consistent with the multivariate trends in all data included in the imputation step, and then adds some random variability so that the resulting data matrix will mimic the uncertainty in relations among variables present in

⁹ Three general categories of missing data are commonly described in the literature. Data are missing completely at random (MCAR) if the probability of missingness is unrelated to the variable itself or to any other variable in the data. Data are missing at random (MAR) if the probability of missing data on a variable is unrelated to that variable after controlling statistically for other variables in the analysis. In other words, MAR allows the probabilities of missingness to depend on observed data but not on missing data. Data are missing not at random (MNAR) if the missing values on a variable are related to the variable, even after controlling for all other variables in the data set.

the nonmissing values (Widaman, 2006). This procedure was particularly attractive for present purposes because the “refusals” variable could be included in the model of missing data. That is, a probably mechanism of missingness was included in the imputation procedure.

The EM procedure begins by estimating the parameters of the data model using the existing data, then it uses these parameters to estimate the missing values, then it uses the complete dataset to re-estimate the parameters, then it uses re-estimated parameters to estimate missing values, and so on, until the process finally converges on stable estimates (Howell, 2008). The EM algorithm offers a simple and elegant solution to the problem of missing values and is widely accepted for psychological applications (Schafer & Graham, 2002).

Parent measures. Missing data within parent measures were generally isolated to one or two items missing from a multi-item scale. The practice recommended by some authors for dealing with missing data in multi-item measures, such as the CBQ, is to calculate the mean of items for which data are present. This method of dealing with missing data has been referred to as ipsative mean imputation (Schafer & Graham, 2002). Although no imputation actually takes place, calculating the mean of available items is considered an imputation approach because it is statistically equivalent to replacing the missing values with the individual’s mean on the remaining items. This approach has three advantages: first, it uses all the available data from an individual to estimate missing values, second, the independence of observations (at least between persons) is maintained because individual scores can be estimated independently of the remaining sample, and third, ipsative mean substitution can be easily accomplished with basic

statistical software. The primary drawback with this approach is that it requires the assumption that all items within a scale are completely interchangeable and equally reliable measures of the underlying construct (Schafer & Graham, 2002). Put in another way, missing and nonmissing values are assumed to be equal in extremity, and missingness is assumed to be unrelated to the difficulty of items or the extremity of their values, had the participants supplied them (Widaman, 2006). This is a somewhat problematic assumption in the present study because it is likely that some values were missing precisely because the actual values were extreme (and the respondent did not want to reveal this fact) or the item was difficult and the person was not sure how to respond (and therefore did not respond). Furthermore, because fewer items are used to calculate the means of the available items, the reliability of the measure is decreased and the variance of the scale likewise tends to increase. In addition, it is difficult to properly interpret the findings related to a variable for which values have been imputed by individual means substitution because the scales for each individual with missing data are (potentially) defined by different sets of items.

Despite the potential problems associated with individual means substitution, Schafer and Graham (2002) suggest that the amount of bias tends to be small when the reliability of items on a scale is greater than $\alpha = .70$. Conceptually, high alpha values indicate that the items in a scale are measuring a unitary construct. Given that internal consistency values for all parent scales were above $\alpha = .70$ (see results section below), individual means substitution seemed reasonable. Furthermore, because individual mean substitution is a common practice for many researchers, it was desirable to use this approach for comparison with results reported by others.

Normality

All variables were screened for outliers, skewness and kurtosis. Two variables had univariate outliers. Before a decision was made about how to handle these outliers, they were screened for the presence of multivariate outliers using Mahalanobis Distance with (conservative) $p < .001$ for the χ^2 value (Tabachnick & Fidell, 2001, p. 68). No cases were multivariate outliers; the problem was therefore limited to individual variables.

The Continuous Performance Task was positively skewed and leptokurtic (skewness = 3.5 kurtosis = 14.4). Four outliers were identified for this variable. Examination of the video tapes revealed that these children understood and were engaged in the task. However, their response patterns suggested that they had genuine difficulties with this task. Based on the assumption that these children's true scores were extreme on this task, their outlier values were replaced with the highest remaining score plus one. Replacing these extreme values with less extreme values attenuated the problem of normality for this variable. The child-report Positive Coping composite was also non-normally distributed (skewness -4.3; kurtosis 19.3). Analysis of the Positive Coping items revealed little variability in the data. Since this variable was not essential for the present analysis, it was dropped from further consideration. All variables were reasonably distributed (i.e., values of skewness and kurtosis below 2), with only minor departures from normality.

Setting

Because children were recruited through two different strategies (community advertisements and daycares), and therefore tested in two different settings (university lab

and daycare respectively), all variables were screened for differences related to setting. Comparison of group means for all study variables, with alpha set at .05 revealed differences on parent-report emotional reactivity, child-report negative coping, affective social understanding, and response inhibition. However, with Bonferonni correction of alpha ($\alpha = .005$ for 11 comparisons) for protection against chance findings no differences remained significant. There were no differences between groups on SES or family setting variables. Although these findings suggest that differences in recruitment and procedures between the daycare and community children may exert a differential influence on these groups, the effect is sufficiently small that it may be ignored. Data from the two groups were therefore combined for analyses.

Executive Function

In the following section, data from the reliability of observational coding for the delay inhibition composite are presented first followed by descriptive data for all EF variables and the description of data reduction procedures.

Observational Coding

The primary investigator coded all video recordings for evidence of delay inhibition (looking at gift, touching gift, latency to first touch, and latency to first peek) and a second coder, blind to the hypotheses of the study, coded 55 videos (46%). Interrater reliability was calculated using intraclass correlation (ICC) using a two-way mixed model analysis of variance (Shrout & Fleiss, 1979).¹⁰ Because only a portion of the tapes were coded for reliability, but all of them were used in further analysis (based

¹⁰ A mixed model analysis of variance is appropriate when the participants are randomly selected (i.e., the interrater reliability sample is randomly selected from the study sample) but the judges are fixed (i.e., all of the ratings come from the same two judges).

on the complete ratings of the primary investigator), the ICC reported here is a single measure reliability, which gives the reliability for a single judge's rating (as opposed to mean ratings from both judges). A measure of absolute agreement was chosen (rather than consistency) because it is a more stringent test of interrater reliability. The intraclass correlations ranged between $\rho = .98$ and $.99$. Ratings on the four indicators were standardized and combined. The resulting scale had an internal consistency of $\alpha = .84$. Higher scores indicated longer latency and therefore better delay inhibition.

Descriptive Data

Descriptive statistics for children's performance on the EF tasks are shown in Table 4. Mean performance on the two response inhibition task was comparable, $t(127) = .063, p > .1$, providing evidence that children responded similarly to the demands of these tasks. In contrast children performed significantly better on the Backward Word Span than Backward Digit Span task, $t(127) = -4.92, p < .001$. These tasks were difficult for many children, but Backward Word Span may have been easier because it always followed Backward Digit Span (i.e., practice effect) or there may be something about a string of words that is easier to transform than a string of digits. Despite differences in levels of performance on these tasks, the overall correlation between them was strong, $r(127) = .75, p < .001$. Correlations among measures of EF, age, and verbal ability are reported in Table 5. As expected, increased performance on EF measures was associated with increased age and verbal ability, with the exception of delay inhibition, which displayed a trend toward increased performance with increasing verbal ability ($p < .1$), but not with increasing age ($p = .90$). The average correlation between EF measures was $r = .26$ with a range from $r = .01$ to $.75$.

Table 4. Descriptive statistics for performance on EF measures

Measure	M	SD	Range	N
DCCS (total correct)	12.08	4.13	6 – 18	127
Backward Digit Span (total correct)	1.08	1.57	0 – 6	127
Backward Word Span (total correct)	1.60	1.79	0 – 6	127
CPT commission errors	12.27	12.47	1 – 51	127
Go/nogo commission errors	12.21	8.55	0 – 34	127
Gift Delay – Delay Inhibition	.03	.79	-2.66 - .80	127

Table 5. Correlations among measures of EF, age and verbal ability

Measure	1.	2.	3.	4.	5.	6.	7.	8.
1. Age	-	.52***	.51***	.46***	.51***	-.24*	-.32***	.01
2. PPVT-III		-	.54***	.47***	.50***	-.30**	-.34***	.16 [†]
3. DCCS			-	.46***	.59***	-.06	-.34***	-.01
4. Backward Digit				-	.75***	-.18*	-.13	-.08
5. Backward Word					-	-.21*	-.25**	.05
6. CPT commission errors						-	.49***	-.20*
7. Go/nogo commission errors							-	-.09
8. Gift Delay – Delay Inhibition								-

[†] $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Data Reduction

EF variables were reduced to three composites based on both theoretical and empirical evidence. As reported above, the two Backward tasks were highly correlated with each other, and this composite was strongly correlated with the DCCS, $r(127) = .56, p < .001$. Therefore, these variables were standardized and combined to form a Working Memory/Cognitive Flexibility (WM/Flexibility) composite.¹¹ Higher scores on this composite reflect better WM/Flexibility. Likewise, commission errors on the CPT and Go/nogo were significantly correlated, $r(127) = .49, p < .001$, and were therefore standardized and combined to form a Response Inhibition composite. Lower scores on this composite indicated fewer errors and therefore better response inhibition. As described above, observational measures of looking and touching were used to generate a Delay Inhibition composite.

Social Understanding

Descriptive statistics for children's performance on the social understanding tasks are shown in Table 6. As expected (see Harris et al., 1986), children's performance on the cognitive social understanding task (i.e., location false belief) was better than their performance on the affective social understanding task (i.e., real-apparent emotion), $t(127) = -2.53, p < .05$. As shown in Table 7, performance on both tasks improved with age and verbal ability.

¹¹ The design of this study called for separate assessment of updating/working memory and flexibility. Commonly used measures of these constructs were included in the EF battery with the intention of generating separate composites from them. However, rather than forming separate aspects of EF, the strong correlation among these measures suggested one underlying construct. Factor analysis with EF measures confirmed that measures of updating/working memory and shifting were part of the same factor. As a result, these measures were combined in the Working Memory/Cognitive Flexibility composite. This composite strongly reflects the operative aspects of EF.

Table 6. Descriptive statistics for performance on social understanding tasks

Measure	M	SD	Range	N
Cognitive social understanding	.74	.87	0 – 2	127
Affective social understanding	.52	.67	0 - 2	127

Table 7. Correlations among measures of social understanding, age and verbal ability

Measure	1.	2	3.	4.
1. Age	-	.52***	.29***	.34***
2. PPVT-III		-	.39***	.42***
3. Cognitive social understanding			-	.21*
4. Affective social understanding				-

* $p < .05$, *** $p < .001$

Emotion Regulation

The variety of ER measures reported here were sufficiently complex to warrant description of individual measures. In the following sections, I first report descriptive statistics for observational and child report measures and then parent report measures of ER. Next, I report the relations among ER measures. Finally, I report procedures for data reduction.

Descriptive Analysis of Observational and Child-Report Measures

Descriptive statistics for observational and child-report measures of ER are displayed in Table 8.

Table 8. Descriptive statistics for performance on ER measures

Measure	M	SD	Range	N
Observational				
Disappointing Gift Positivity	.73	.80	0 – 3	127
Disappointing Gift Negativity	2.15	1.39	0 – 5	127
Child-Report				
Emotion Coping (negative)	2.52	1.72	1 – 5	127
Parent-Report				
Emotion Questionnaire	3.67	.70	1 – 5	127
Children's Coping Scales	4.14	.80	2 – 5.78	127

Disappointing Gift. Interrater reliability of observational coding for the Disappointing Gift task was assessed using a two-way mixed model for a single rater (as described previously). Reliability was moderate for both the positive and negative aggregates ($\rho = .63$ and $.60$ respectively). The combined items for positive and negative expression of emotion had moderate internal consistency ($\alpha = .45$ and $\alpha = .46$ respectively). As expected, children displayed significantly more negative than positive

emotion after receiving the disappointing gift $t(125) = -8.84, p < .001$. Males and females did not differ in their display of positivity, $t(125) = .10, p < .1$, or negativity, $t(125) = .18, p < .1$. Contrary to expectations, older children and children with better verbal abilities displayed *poorer* negative emotion regulation during the disappointing gift task ($r_s .24$ and $.20, p < .05$ for age and verbal ability respectively) than younger children and children with lower verbal abilities. Surprisingly few children admitted to not liking the gift ($n = 4$) in response to the question “do you like your gift?” More commonly, children did not respond to this question.

Emotion Coping. Two aggregate scores were generated from children’s responses to the three emotion arousing vignettes. First, the 6 positive coping items were combined. This aggregate, however, did not cohere well ($\alpha = .16$), and attempts to improve coherence by eliminating items were not successful. This variable also was strongly skewed (as reported previously, and since it was not essential for the present analysis, it was dropped from further consideration. Second, a Negative Coping score was derived by aggregating the negative coping items. One of the six negative coping items was not significantly correlated with the other items and it was therefore removed. The remaining 5 items had high internal consistency ($\alpha = .75$).

Descriptive Analysis of Parent-Report Measures

Descriptive statistics for parent-report measures of ER are displayed in Table 7.

Children’s Coping Scales. Parent ratings of emotion coping for all nine coping strategies were compared across the three vignettes to determine if scores could be aggregated across vignettes. Cronbach’s alpha for the 9 three-item scales ranged between .69 and .88 with an average alpha of .78. Based on these good to very good internal

consistencies, ratings from the three vignettes were aggregated to generate a mean score for each of the 9 coping strategies.

To reduce the number of variables, negative coping items were first reverse scored and then all coping items were standardized and combined to generate an overall measure of emotion coping.¹² Internal consistency for the combined items was high ($\alpha = .80$). Higher scores on this composite indicated more adaptive emotion coping abilities. There were significant differences between boys and girls on this measure of ER, $t(127) = -2.39, p < .05$, with girls receiving higher ratings of emotion coping ability.

The Emotion Questionnaire. Parent ratings of children's emotion regulation on the 20-item Emotion Questionnaire had a mean of 3.67 with a standard deviation of .70 and a range of 1 – 5. The internal consistency of the items was high ($\alpha = .86$). These values are comparable to those reported by the authors in the standardization sample (Rydell et al., 2004). Ratings on the Emotion Questionnaire were unrelated to age, verbal ability, and sex.

Relations Among ER Measures

The correlations between measures of ER, reported in Table 9, reveal several important patterns. First, observational, child-report, and parent-report measures were not alternate forms of the same assessment. This was evident from the generally low intercorrelations among different measures of ER. Second, variables that shared a common metric or method showed stronger relations than variables that differed in metric

¹² Designation of coping items as positive or negative was based on theoretical considerations and previous research (see Eisenberg et al., 1993). As a further check on the function of these items within the present sample, a principle components analysis was conducted to determine the sign of each item when the solution was constrained to one principle component. All items performed as expected, loading positively onto the 1st principle component.

or method. For example, the two parent report measures of ER were significantly correlated, as were the two measures of ER derived from the disappointing gift procedure. Third, different measures led to different conclusions about underlying ER abilities. For example, children who reported more negative strategies for dealing with emotional situations were at the same time rated as better emotion regulators by their parents. Finally, the relations between age, verbal ability and ER were not consistent across different measures of ER. Thus, the overall pattern of relations among measures of ER was complex.

Data Reduction

Although measures of ER demonstrated poor coherence as a whole, parent-report measures were significantly correlated. These measures were standardized and combined to create a parent-report ER composite. Likewise, the two measures of ER from the disappointing gift task were significantly correlated; they were therefore standardized and combined (negativity was reversed so that higher scores indicate better ER). Emotion Coping was not included in this composite because of its low correlation with measures that were included. The parent-report and observational composites were unrelated, $r(127) = .05, p > .1$. Separate analyses were conducted for these two ER composites.

Emotional Reactivity

In the following section, reliability and descriptive data for observational coding of emotional reactivity from the Gift Delay task are presented first followed by descriptive data of parent-report ratings of emotional reactivity.

Table 9. Correlations among ER measures

Measure	1.	2.	3.	4.	5.	6.	7.
1. Age	-	.52***	-.29***	.24**	.12	.05	.27**
2. Verbal Ability		-	-.23**	.20*	.14	-.02	.15 [†]
3. Emotion Coping (child-report)			-	.17 [†]	-.01	.18*	-.10
4. Disappointing Gift Negativity (observational)				-	-.20*	-.03	-.03
5. Disappointing Gift Positivity (observational)					-	.07	.01
6. Emotion Questionnaire (parent-report)						-	.35***
7. Children's Coping Scales (parent-report)							-

[†] p < .10, * p < .05, ** p < .01, *** p < .001

Observational Measures of Emotional Reactivity

As reported in the methods section, the Gift Delay task was used to assess both delay inhibition (reported previously) and emotional reactivity. Coding of emotional reactivity was done independently of the delay inhibition coding. A research assistant (not the same person who coded delay inhibition) blind to the study hypotheses coded all video recordings for evidence of emotional reactivity using a modified version of the FACES coding scheme (see methods). The primary investigator coded a random sample of 10% of the video recordings for the purpose of calculating interrater reliability. As described previously, interrater reliability was calculated using ICC with a two-way analysis of variance (Shrout & Fleiss, 1979). A measure of absolute agreement was chosen (rather than consistency) because it is a more stringent test of interrater reliability. The intraclass correlations for overall ratings of positivity and negativity were $\rho = .83$ and $.91$ respectively. Ratings of positive emotion and negative emotion were standardized and combined to provide separate estimates of positivity and negativity. The resulting scales had internal consistency of $\alpha = .73$ and $.55$ respectively.

Descriptive statistics for the observational measure of emotional reactivity are reported in Table 10. To examine differences between positivity and negativity displayed during the delay procedure, mean differences in positivity and negativity on each of the 4 indicators (i.e., frequency and intensity of facial and non-facial emotion) were examined using paired t tests. With a Bonferonni correction to alpha for 4 comparisons ($\alpha = .0125$), significant differences in the *intensity* of facial display were observed between

Table 10. Descriptive statistics for emotional reactivity in the Gift Task

Measure	M	SD	Range	N
Negativity	-.001	.74	-1.32 – 2.15	127
Positivity	-.009	.80	-1.0 – 2.55	127
Overall reactivity	2.78	.91	1 – 5	127

positive and negative emotions $t(125) = -3.05, p < .01$ and in the *frequency* of non-facial indicators of positivity and negativity $t(125) = 2.60, p < .01$. Children also tended to display negative facial emotion more frequently than positive facial emotion, but the trend was not significant ($p = .31$). Thus, children tended to display negative emotions more frequently but they displayed positive emotions more intensely. Taken together, this evidence suggests the delay situation was mildly aversive for preschoolers and that children experienced a genuine conflict between the draw of the gift and the constraints of the situation.

Parent-Report Measures of Emotional Reactivity

Parent-report of emotional reactivity was measured by two scales that were combined to generate a composite. Descriptive statistics of parent ratings for negative affectivity (CBQ) and negative emotionality (the Emotion Questionnaire) along with the composite of these scales are reported in Table 11. Descriptive statistics for the Emotion Questionnaire are comparable to those reported by the authors for a sample of preschoolers (Rydell et al., 2004). The mean for the CBQ reported here is somewhat lower than the mean reported by the developers of the CBQ for several samples of 3- to

5-year-olds (combined $n = 666$, mean = 4.09, range = 1.3 – 6.77; Rothbart et al., 2001). One reason for this difference was that the current report was based on the short form of the CBQ whereas the findings published by the authors were based on the standard version. Means for the short form of the CBQ have not been previously published. Internal consistency for the CBQ negative affectivity and EQ negative emotionality scales were $\alpha s = .77$ and $.80$ respectively. The composite measure of negative reactivity had high internal consistency ($\alpha = .71$). These alphas are somewhat higher than those reported in standardization samples for the CBQ ($\alpha = .70$; Putnam & Rothbart, 2006) and Emotion Questionnaire ($\alpha = .71$; Rydell et al., 2003, 2004). Age $r(127) = -.13, p > .1$, verbal ability $r(127) = -.08, p > .1$, and sex $t(125) = -.47, p > .1$, were unrelated to parent report of emotional reactivity.

Table 11. Descriptive statistics for parent-report of child negative emotionality

Measure	M	SD	Range	N
CBQ Negative Affectivity	3.52	.69	2.11 – 5.56	127
EQ Negative Emotionality	2.82	.66	1.25 – 4.75	127
Negative Reactivity Composite	0.00	.88	-2.04 – 2.74	127

Relations Among Measures of Emotional Reactivity

The observational emotional reactivity composite was negatively correlated with the parent-report emotional reactivity composite, $r(127) = -.16, p = .08$. Thus, as with measures of ER, observational and parent-report measures of emotional reactivity lead to different conclusions about the nature of the child's negative emotional responses. These counterintuitive results are examined in more detail in the Discussion.

Temper Tantrums

Descriptive Statistics

Parents of 22 children (17% of the sample) reported that they had not observed a temper tantrum in the past month. These children were therefore eliminated from further analyses of the temper tantrum data. T-tests with age, sex, and verbal ability revealed no significant differences between tantrummers and non-tantrummers. Descriptive statistics for parent ratings of the frequency and intensity of common tantrum behaviours are reported in Tables 12 and 13 respectively.

As demonstrated by the prevalence scores in Table 12, parents reported observing some behaviours more frequently than others. For example, all children reportedly cried during tantrums but not all children became aggressive (i.e., hitting, kicking, or throwing). The frequencies of behaviours were strongly related to their intensity (mean $r = .71$). Tantrum behaviours that were more frequent were also, on average, performed more intensely.

Table 12. Descriptive statistics for frequency of common tantrum behaviours

Behaviour	M	SD	Range	Prevalence	N
Cry	3.98	.95	2 – 5	1.0	105
Whine	3.80	1.01	1 – 5	.98	105
Yell Words	3.36	1.04	1 – 5	.95	105
Scream	2.62	1.40	1 – 5	.71	105
Throw	2.14	1.02	1 – 5	.67	105
Run away	2.48	1.19	1 – 5	.71	105
Hit	2.16	1.00	1 – 5	.67	105
Stamp	2.17	1.12	1 – 5	.63	105
Kick	1.96	.96	1 – 4	.59	105
Push/pull	2.45	1.09	1 – 5	.77	105

Note: prevalence is the decimal fraction of children for which parents report this behaviour occurring during tantrums in the past month.

Data Reduction

As described in the methods section, paired ratings of frequency and intensity for each behaviour were first multiplied and then summed across behaviours to generate a total score (mean = 66.23, *SD* = 27.38, range = 10 - 153). Higher scores indicated more severe tantrums.

Table 13. Descriptive statistics for intensity of common tantrum behaviours

Behaviour	M	SD	Range	N
Cry	2.75	.76	1 – 4	105
Whine	2.72	.72	1 – 4	105
Yell Words	2.60	.95	1 – 4	105
Scream	2.22	1.05	1 – 4	105
Throw	1.77	.82	1 – 4	105
Run away	1.87	.88	1 – 4	105
Hit	1.81	.85	1 – 4	105
Stamp	1.73	.89	1 – 4	105
Kick	1.66	.85	1 – 4	105
Push/pull	2.02	.98	1 – 4	105

Statistical Tests of Study Hypotheses

Statistical tests of study hypotheses are reported in three sections. First, I examine the unique contribution of different aspects of executive function and social understanding to emotion regulation. Next I examine the relation between temper tantrums and cognitive, social, and emotional aspects of self-regulation. Finally, I examine the role of ER in mediating the relation between emotional reactivity and temper tantrums.

The Contribution of EF and Social Understanding to ER

To address the goal of identifying the contribution of EF and social understanding to ER, several hierarchical multiple regression equations were estimated separately for the parent and child ER composites. In each model, age, sex, verbal ability, and emotional reactivity were entered first as control variables. Social understanding variables were entered in the second step and the EF variables in the final step.

Parent-report. The regression model for parent-report ER was significant $F(9, 117) = 10.18, p < .001$ and explained 45% of the variance in emotion regulation. Table 14 displays results from the final model. Among the control variables, both age and emotional reactivity accounted for significant variance in ER. As expected, increasing age was associated with better ER and higher emotional reactivity with poorer ER. Among the social understanding variables, affective social understanding but not cognitive social understanding was associated with poorer ER. In contrast to the expectation that increases in affective social understanding would be related to increases in ER, affective social understanding and ER were inversely related. None of the EF variables was associated with ER in this analysis.¹³

Child-report and observation. A second hierarchical regression analysis was conducted predicting observational measures of ER from EF and social understanding. For this analysis, the observational measure of emotional reactivity from the Gift Delay task was used as a control variable. Age, sex, and verbal ability were also included as control variables. As shown in Table 15, the overall model was not significant, $F(9, 117) = .65, p > .1$.

¹³ This analysis was also conducted with the EF variables in the 2nd step and the social understanding variables in the third. The pattern of results remained the same. However, with the EF variables entered prior to the social understanding variables, the combined effect of the social understanding variables no longer remained significant.

Table 14. Hierarchical regression analysis predicting parent-report ER from social understanding and EF

Step Variables	β	ΔR^2	ΔF	Df
1. Age	.21*	.42	21.64***	4, 122
Sex	.15*			
Verbal ability	.05			
Emotional Reactivity	-.60***			
2. Affective Social Understanding	-.16*	.02	2.38 [†]	2, 120
Cognitive Social Understanding	.04			
3. Delay Inhibition	-.01	.01	.12	3, 117
Response Inhibition	-.01			
WM/Flexibility	-.06			
Model test		.45	10.18***	9, 117

[†] $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Given the low coherence of observational measures of ER, the null results of the hierarchical regression analysis were not surprising. Low coherence may indicate that patterns among measures of ER are complex. Although one explanation of these results is that observational measures had insufficient resolution to reliably estimate children's ER abilities, another explanation is that variability of performance is to be expected (Campos et al., 2004). It may be the case, for instance, that some children perform rather poorly in some situations but well in others. If the patterns of poor and good

Table 15. Hierarchical regression analysis predicting observational measures of ER from social understanding and EF

Step Variables	β	ΔR^2	ΔF	Df
1. Age	.02	.01	.334	4, 122
Sex	.11			
Verbal ability	.14			
Emotional Reactivity	-.05			
2. Affective Social Understanding	-.11	.02	1.10	2, 120
Cognitive Social Understanding	-.06			
3. Delay Inhibition	-.02	.02	.776	3, 117
Response Inhibition	.12			
MW/Flexibility	-.13			
Model test		.07	.650	9, 117

performance are randomly distributed across participants, the result is low coherence in measures (Mischel, 2004).

An alternate explanation is that different patterns of results across the various measures of ER indicated meaningful differences between children. For example, children who consistently scored high on various measures of ER may represent a group of children whose ER abilities were meaningfully different from children who consistently scored low on those measures of ER. To explore this possibility, further

analyses were conducted with observational and child report measures to identify children who were simultaneously high or low on several measures.

To strengthen the conceptual validity of this approach, multitrait and multimethod variables were combined. The Emotion Coping variable is a child report measure of children's cognitions related to ER and the Disappointing Gift Negativity variable is an observational measure of expressive control while experiencing disappointment. Among the child-report and observational measures, these variables displayed the strongest correlation (see Table 9). These two variables were therefore used to identify children high and low in ER. A two step procedure was used to identify groups of children who consistently scored high or low across the two ER measures. First, cut points were established to create 3 equal groups for both the Emotion Coping and Disappointing Gift Negativity measures. Children within the bottom and top third were retained for further analysis. Second, children from this subsample who were simultaneously low (i.e., had good ER) on both measures were assigned to a high ER group ($n = 23$) and children who were simultaneously high on both measures (i.e., had poor ER) were assigned to a low ER group ($n = 24$).

To better understand the nature of the groups generated through this procedure, group comparisons were conducted with control and demographic variables. Alpha was adjusted to .01 to decrease the probability of finding spurious group differences when conducting multiple comparisons. Significant group differences were observed for sex $t(47) = -2.69, p = .01$, and parent education $t(47) = -3.65, p = .001$, but not for verbal ability, age, or observed emotional reactivity. Thus, within these groups, there were

significantly more girls in the high ER group, and children in the high ER group had parents with more education than children in the low ER group.

To test for the effect of EF and social understanding on group membership, data were analyzed using sequential logistic regression. In step one, sex, parent education, and observed emotional reactivity were entered as control variables. Social understanding variables were added in step 2, and the EF variables were added in the final step. The overall model was significant, $\chi^2(47, 8) = 30.72, p < .01$, Nagelkerke $R^2 = .62$, indicating that the predictors, as a set, reliably predicted ER group. As shown in Table 16, sex and parental education were significant demographic predictors of ER, Nagelkerke $R^2 = .40$. Females were 16 times more likely than males to display good ER across several situations. For every additional year of parent education, children were 4 times more likely to display good ER. Social understanding did not contribute significantly to predicting group membership in this model. In contrast, EF did contribute to the prediction of ER with an incremental 22% of variance explained (Nagelkerke $R^2 = .22$). Of the EF variables, both the delay and response inhibition composites contributed significantly to predicting group membership. For every unit increase in delay inhibition, children were more than three times more likely to display good ER. Likewise, for every unit increase in response inhibition (note that low scores on response inhibition indicate better ability) the odds of being in the high ER group decreased by 77%. Thus, better ER was associated with better performance on both the delay and response inhibition tasks. The model correctly classified 82.6% of children in the high ER and 91.7% of children in the low ER group.

Table 16. Logistic regression analysis predicting ER group from social understanding and EF

Step Variables	B	χ^2	df	Odds Ratio
1. Sex	2.77*	13.52**	38, 3	15.97
Parent Education	1.46**			4.31
Emotional Reactivity	.09			1.09
2. Affective Social Understanding	-.32	.24	38, 2	.72
Cognitive Social Understanding	-.30			.74
3. Delay Inhibition	1.23 [†]	9.90*	38, 3	3.42
Response Inhibition	-1.46*			.23
WM/Flexibility	-.98			.38
Constant	-11.35			.00
Model test		30.72***	47, 8	

[†] $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

The Contribution of ER, EF, and Social Understanding to Temper Tantrums

The next analysis focussed on the association between temper tantrums on the one hand and ER, EF, and social understanding on the other. This analysis included only those children whose parents reported observing a tantrum in the past month ($n = 105$). As shown in Table 16, correlations between temper tantrums and all other variables were low, with the exception of parent report measures of emotional reactivity and ER. As expected, children with higher parent ratings of ER had lower temper tantrum scores

Table 17. Correlations between temper tantrums and study measures

Measure	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Age	-	.53***	-.08	.02	-.30**	.60*	.30**	.29**	-.06	-.21*	-.06	.24**	-.30**	-.03
2. Verbal ability		-	-.01	.16	-.39***	.61***	.42***	.38***	-.05	-.28**	-.09	.07	-.27**	-.04
3. Parent education			-	.03	-.11	.08	.13	.13	-.16 [†]	-.11	.29**	.07	-.17 [†]	-.08
4. Delay Inhibition				-	-.16	-.02	-.03	-.04	.06	-.02	-.07	-.04	-.12	-.11
5. Response Inhibition					-	-.28**	-.29**	-.19 [†]	-.08	.35***	.14	-.10	.31***	-.03
6. WM/Flexibility						-	.41***	.36***	-.01	-.32***	-.15	.07	.31***	.15
7. Affective Social Understanding							-	.19*	.05	-.17 [†]	-.10	-.06	-.24*	.10
8. Cognitive Social Understanding								-	.02	-.27**	-.12	.06	-.08	.08
9. Negative reactivity (parent report)									-	-.21*	-.06	-.56***	-.09	.52***
10. Negative reactivity (observational)										-	-.01	.01	.13	-.12
11. ER (observational)											-	-.03	-.17 [†]	.04
12. ER (parent report)												-	.04	-.44***
13. Negative Coping (child report)														-.10
14. Temper Tantrums														-

[†] $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

while children with higher emotional reactivity ratings had higher temper tantrum scores. None of the correlations between temper tantrums and observational measures of ER, EF, or social understanding was significant. The correlation between delay inhibition and temper tantrums, however, was in the expected direction (i.e., delay inhibition was associated with decreased temper tantrums). In contrast, the correlations between temper tantrums and the remaining observational measures of self-regulation suggested that improvements in these aspects of self-regulation were associated with *increases* in temper tantrums, although these correlations were low and non-significant.

Hierarchical regression analysis was used to test the hypothesis that ER would predict temper tantrums even after controlling for emotional reactivity and other aspects of self-regulation. Variables for this analysis were selected based on their patterns of correlations and their interpretability within the existing model of self-regulation – that is, better EF and social understanding should be related to better regulation of emotion. Variables with zero order correlations that could not be interpreted within this model (i.e., social understanding aggregates, Response Inhibition composite, and WM/Flexibility composites) were excluded. In the first step, verbal ability, age, parent education, and parent ratings of emotional reactivity were included as control variables. In the second step, delay inhibition was included. Parent ratings of ER were entered in the final step.

As shown in Table 18, the regression equation was significant $F(5,99) = 9.48, p < .001$, and explained 32.4% of the variance in temper tantrums. The findings are consistent with the previous analysis showing that inhibitory control contributes to the ability to control emotion. In this analysis, delay inhibition was associated with temper tantrums even after controlling for age, verbal ability and emotional reactivity. The

Table 18. Hierarchical regression analysis predicting temper tantrums from EF and ER

Step Variables	β	ΔR^2	ΔF	df
1. Age	.03	.268	12.33***	3, 101
Verbal ability	.04			
Emotional Reactivity	.40***			
2. Delay Inhibition	-.15 [†]	.022	3.05 [†]	1, 100
3. ER (parent report)	-.23*	.034	4.99*	1, 99
Model			9.48***	5, 99

[†] $p < .10$, * $p < .05$, *** $p < .001$

direction of the association indicated that children who displayed more restraint in the gift delay task also displayed fewer and less severe temper tantrums. Parent ratings of ER accounted for a significant amount of variance in temper tantrums over and above control variables and delay inhibition. The direction of the association was consistent with the interpretation that high ER is associated with lower levels of temper tantrums, even after taking into account age, verbal ability, emotional reactivity and delay inhibition.

Relations Between Emotional Reactivity, Emotion Regulation, and Temper Tantrums

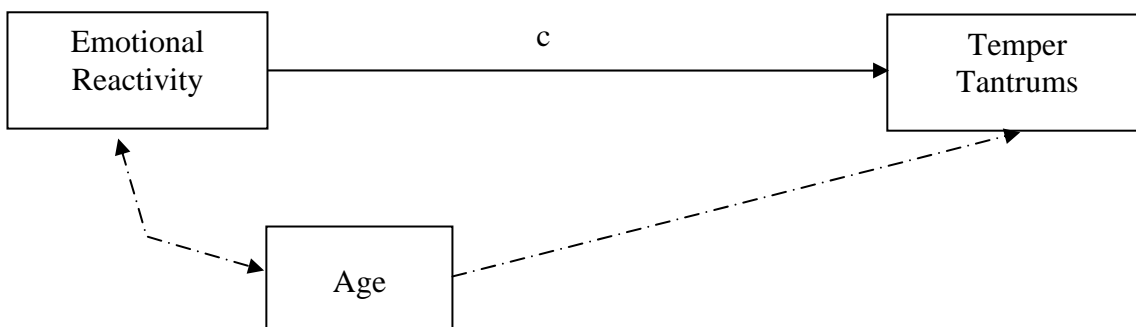
The final analysis examined the hypothesis that ER mediates the relation between emotional reactivity and temper tantrums. A mediation hypothesis posits how, or by what means, an independent variable (X) affects a dependent variable (Y) through an

intervening variable (M) (Preacher & Hayes, in press). In other words, it examines the indirect effect of one variable on another by way of a third variable. According to MacKinnon, Lockwood, Hoffman, West, and Sheets (2002), the most accessible approach to mediator analysis is the *causal steps strategy* popularized by Baron and Kenny (1986). Recent critique of this approach, however, has revealed several shortcomings that call into question its suitability for testing mediation hypotheses in studies with small samples. Given the prominence of the causal steps strategy in the psychological literature, I briefly describe the problems associated with it and alternate strategies that address these problems.

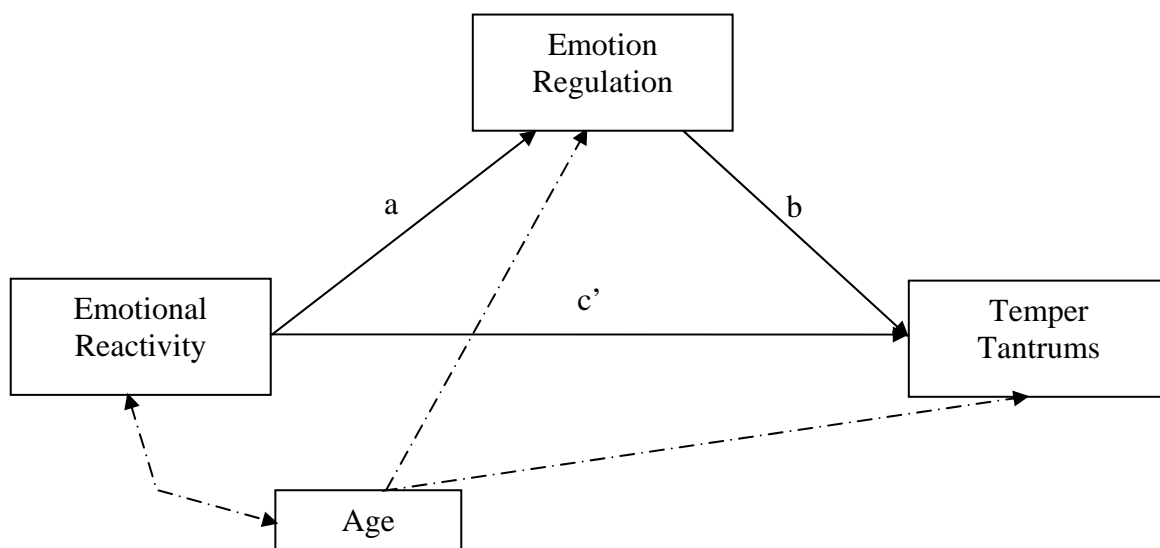
In the causal steps strategy, as applied to the current analysis, ER is considered a mediator if: (a) the independent variable, emotional reactivity, significantly accounts for variability in ER (*a* in Figure 2), (b) emotional reactivity significantly accounts for variability in the dependent variable, temper tantrums (*c* in Figure 2), (c) ER significantly accounts for variability in temper tantrums when controlling for emotional reactivity (*b* in Figure 1), and (d) the effect of temperamental reactivity on temper tantrums decreases substantially when ER is entered simultaneously with temperamental reactivity as a predictor of temper tantrums (*c'* in Figure 2). Perhaps the most pertinent of the criticisms of the causal steps strategy is that it neglects directly testing for the indirect effect (Preacher & Hayes, 2004). It is, so to speak, an indirect way of testing for an indirect effect. Although drawing inferences from a logical series of equations is a reasonable practice, direct tests of mediator relations are readily available. The Sobel test (Sobel, 1982, 1986) is one example (described further below) of a formal and direct test of the

Figure 2. Emotion regulation mediation model with age as covariate

Panel A: Illustration of the direct effect of Temperament on Temper Tantrums controlling for age.



Panel B: Illustration of a mediation design – Temperament affects Temper Tantrums indirectly through Emotion Regulation controlling for age.



indirect effect. Another criticism is that the causal steps strategy includes criteria that are now generally recognized as immaterial to questions of mediation. Specifically, the requirement that the independent variable significantly accounts for variability in the dependent variable (c in Figure 2) is unnecessary (Frazier, Tix, & Barron, 2004; Preacher & Hayes, 2004).¹⁴ A third problem is that the causal steps strategy suffers from low power in most situations, especially when sample sizes are small (MacKinnon et al., 2002).

The *product of coefficients* approach (i.e., the Sobel test) addresses some of these shortcomings. It involves computing the ratio of the product ab (see Figure 2) to its estimated standard error (SE) (Preacher & Hayes, 2004). Conceptually, this is a test of whether the mediator significantly reduces the effect of the independent variable on the dependent variable ($c - c'$ in Figure 2). The Sobel test is based on the assumption that the ratio of the indirect effects to its standard error is normal – an assumption that is appropriate only for very large samples (Preacher & Hayes, 2004). In smaller samples, bias introduced by the skewed distribution of SE results in significance tests with inflated Type I error.

To address the shortcomings of the *product of coefficients* approach, bootstrap procedures have been applied to mediation analysis (Preacher & Hayes, 2004; Shrout & Bolger, 2004). *Bootstrapping* is a nonparametric sampling procedure used to generate a sampling distribution of ab from multiple (i.e., 5000) random samples with replacement

¹⁴ Although the terms *mediated effects* and *indirect effects* are often used interchangeably, Preacher and Hayes (2004) observe that mediated effects are a special case of the more general category of indirect effects. An indirect effect exists when the relation between an independent and dependent variable is caused by an intervening variable. There is no assumption that a total effect exists between the independent and dependent variables. A mediated effect, on the other hand, does imply a total effect that exists independent of the intervening variable.

from the original sample. The product ab is estimated for each resample. The values of ab are then sorted from high to low, with the upper and lower bounds of the confidence interval (CI) defined as the percentile values associated with the desired CI. For example, to derive the 95% confidence interval of a sampling distribution of 1000 resamples of ab , the estimated values of ab are sorted from low to high. The lower limit of the confidence interval is defined as the 25th score in this sorted distribution, and the upper limit is defined as the 976th score in the distribution. The resulting distribution is often asymmetric (viz. the upper and lower ends of the confidence interval are not equidistant from zero) because such percentile based confidence intervals make no symmetry assumptions about the sampling distribution (Preacher & Hayes, in press). The bias correction works by adjusting the ordinal position of the ab values in the sorted distribution of ab that are used as the upper and lower bounds of the confidence interval (Preacher, Rucker, & Hayes, 2007).¹⁵ The results of this procedure have been shown to have high power while maintaining reasonable control over the Type I error rate (MacKinnon et al., 2002), and are currently recommended as best practice in developmental psychology (Widaman, 2006). The test of significance for the mediator hypothesis is whether or not the resulting CI spans zero. If the CI contains zero, then the indirect effect is not significantly different from zero (with the probability of error defined by the CI).

To test the hypothesis that emotion regulation mediates the relation between emotional reactivity and temper tantrums, the indirect effect of emotional reactivity on

¹⁵ One minor drawback of this approach is that bootstrapping yields slightly different CIs each time this method is applied to the same data. This problem is diminished when sufficiently large numbers of *resamples* are taken to construct the sampling distribution (i.e., 5000). In the present analysis, coefficients did not change (to the third decimal point) when conducting multiple independent runs of the bootstrapping procedure.

temper tantrums was estimated using the SPSS macro discussed in Preacher and Hayes (in press). Age was included as a covariate because it was significantly correlated with ER. Thus the test in the present analysis was whether ER intervenes in the relation between temperamental reactivity and temper tantrums after removing the effects of age. Only parent-report measures of emotional reactivity and ER were used in the mediation analysis because they were related to temper tantrums whereas observational measures were not. Using bias corrected and accelerated bootstrap confidence intervals with 5000 resample, the lower and upper limits of the 99% CI were .0018 and .0137 respectively. Since the confidence interval does not span zero, these results support the inference that ER significantly intervenes in the relation between emotional reactivity and temper tantrums. The signs of the path coefficients (see Table 19) are consistent with the interpretation that emotion regulation significantly reduces the effect of emotional reactivity on temper tantrums.

Table 19. Summary of path coefficient estimates for the ER mediator model

Path	Unstandardized Coefficient	S.E.	<i>t</i>	<i>p</i> (two-tail)
c	.0160	.0026	6.10	< .000
a	-.0133	.0027	-5.00	< .000
b	-.4310	.0881	-4.89	< .000
c'	.0102	.0026	3.88	< .000
Partial effect of age	.0058	.0088	.655	.51

Note: Path designations refer to figure 2. Model summary for DV model $R^2 = .41$, Adj $R^2 = .39$, $F(3, 101) = 23.38$, $p < .000$

Table 19 can be interpreted as follows:

c – Test of the *c* path refers to the total effect of emotional reactivity on temper tantrums after controlling for age. Conceptually, this is emotional reactivity regressed on temper tantrums with age as a covariate. The point estimate is statistically different from zero, meaning that emotional reactivity accounts for a significant amount of variance in temper tantrums. The sign of the coefficient indicates that children who were rated higher in emotional reactivity also displayed more severe temper tantrum.

a – Path *a* tests the effect of emotional reactivity on the proposed mediator, ER, after controlling for age. This is emotional reactivity regressed on ER with age as a covariate. This effect is statistically different from zero, and the coefficient indicates that children rated higher in emotional reactivity displayed poorer ER.

b – Test of path *b* examines the effect of ER on temper tantrums after controlling for age and emotional reactivity. Conceptually, this is ER regressed on temper tantrums with age and emotional reactivity as covariates. The effect is statistically significant. Children who were better at regulating their emotions had less intense temper tantrum, even after controlling for their emotional reactivity.

c' – Finally, path *c'* tests the direct effect of emotional reactivity on temper tantrums after controlling for age and ER. Conceptually, this is emotional reactivity regressed on temper tantrums with ER and age as covariates. It is a test of the unique relation between emotional reactivity and temper tantrums after controlling for ER. In cases where there is complete mediation, the unique relation is non-significant. When mediation is partial, as is the case here, the

unique relation remains significant, indicating that the effect of emotional reactivity on temper tantrums remains even after controlling for ER.

$c-c'$ – Conceptually $c-c'$ is equivalent to the product ab , and this forms the actual test of mediation. It is not reported in the table because a point estimate was not used to evaluate the statistical significance of mediation. As described previously, a bootstrap method was used to construct a 99% confidence interval and was reported as .0018 - .0137. Since this CI does not span zero, we can infer that the mediator effect is non-zero with a 1% chance of error.

Discussion

The aim of this study was to investigate the nature and strength of the relations between ER and other aspects of self-regulation in typically developing preschoolers. Toward this end, preschool children completed batteries of EF, ER, emotional reactivity, and social understanding, and parents reported on children's emotional reactivity, ER, and temper tantrums. This study extends previous research by including multitrait, multimethod assessment of EF, ER, and social understanding, and controlling for verbal ability and emotional reactivity. Exploration of temper tantrums offers a unique illustration of the manner in which aspects of self-regulation contribute to everyday displays of strong emotion in preschoolers.

Summary of Findings

Overall, the results of this investigation provided evidence that aspects of EF and social understanding are related to ER and that these abilities are related to temper tantrums. This study makes three main contributions to understanding children's self-regulation. First, there was evidence of a relation between ER and aspects of EF and social understanding even after individual differences in emotional reactivity and verbal ability had been removed. Among the social understanding variables, only affective social understanding was a useful predictor in the regression model, when emotional reactivity and demographic variables were entered first. Among the EF variables, there was evidence that individual differences in both response and delay inhibition contributed significantly to ER. This finding replicates and extends Carlson and Wang's (2007) findings of partial correlation (controlling for verbal ability) between inhibitory control and ER. Second, individual differences in both delay inhibition and ER contributed to

the prediction of temper tantrums, even after controlling for emotional reactivity. Social understanding variables were not included in this analysis because correlations between social understanding and temper tantrums were low. Finally, this study supports the hypothesis that ER buffers the relation between emotional reactivity and temper tantrums. That is, the effect of emotional reactivity on temper tantrums is significantly reduced by ER. As with most mediators of psychological processes, ER is considered a partial mediator because emotional reactivity continued to have a direct effect on temper tantrums, even after controlling for ER. These findings suggest that aspects of EF and social understanding make unique contributions to ER and that ER is an important factor in the control of temper tantrums.

Contribution of EF and Social Understanding to ER

ER-EF

Research on the relation between ER and EF is an emerging topic in the child development literature. To date, there is limited information about its nature or strength. Previous studies provided a basis for hypothesizing that both response inhibition (Hoeksma et al., 2004) and delay inhibition (Liebermann, et al., 2007) were related to ER. Furthermore, Carlson and Wang (2007) found that a composite measure of response and delay inhibition was related to children's ER, even after controlling for age and verbal ability. The results reported here extend these findings by suggesting that response and delay inhibition make independent contributions to ER abilities. In addition, by controlling for age, verbal ability, and emotional reactivity, these findings suggest that the association between inhibitory control and ER cannot be accounted for

by general developmental or general emotional processes. To interpret these results, I consider several ways in which response and delay inhibition may contribute to ER.

ER-response inhibition. Understanding the relation between response inhibition and ER may hinge upon the role of emotion in human adaptation in several ways. First, the ability to inhibit a prepotent response may contribute to the process of regulating emotions because, at least with regard to negative emotions, emotions are themselves prepotent responses that must be inhibited. Most emotion researchers would agree that emotion is a pattern of behaviour comprised of at least the following four components: (a) an event of emotional significance is accompanied by, (b) physiological and motoric changes (such as heart rate, facial, and postural changes), and both are, (c) evaluated cognitively, and, (d) may lead to a subjectively experienced emotion (Kagan, 1994). In other words, emotions generate “quick-and-dirty” appraisals of situations (LeDoux, 1995), and allocate perceptual, cognitive, and bodily resources to meet the perceived situational challenges (Stemmler, 2004). Although such rapid appraisal and activation systems have clear survival value, their efficiency depends on the system’s ability to selectively attend to the features of the situation (Öhman, 2002) and to activate a highly specific response tendency (Fischer, Shaver, & Carnochan, 1990; Frijda, Kuipers, & ter Schure, 1989). Christianson (1992), for example, has shown that negative emotion biases attention toward focal aspects of the situation that are emotionally relevant. Such focal attention has the tendency to feed back in continuous appraisal, biasing the evaluation of the situation toward the activated emotion (Philippot, Baeyens, Douilliez, & Francart, 2004). From a regulation perspective, these evaluation and action biases must be overcome to allow for the attenuation, inhibition, or substitution of the activated emotion.

Successful ER, by this account, requires inhibitory control of the prepotent emotional response.

Second, response inhibition may contribute to ER by generating psychological distance from emotions (Carlson, Davis, & Leach, 2005; Cunningham & Zelazo, 2007). Psychological distancing captures the phenomenon that human beings can step back and withhold an immediate response, survey the environment, and reflect on the course of action instead of being dominated by immediate stimulation. One of the bases for the claim that inhibitory control contributes to ER by generating psychological distance from emotions is that prefrontal and limbic systems are extensively and reciprocally interconnected brain structures (Blair, Zelazo & Greenberg, 2005). Prefrontal areas are known to be important for the exercise of executive functions (Banfield et al., 2004), while limbic structures are associated with emotional reactivity, the stress response, and autonomic function (Blair et al., 2005). The interconnection of executive and emotional systems makes it possible for response inhibition to delay emotional responding long enough to allow slower cortical appraisal processes to reapply the basic appraisal processes to the emotional action tendencies themselves (Cunningham & Zelazo, 2007; Fischer et al., 1990; Lewis & Todd, 2007). Psychological distancing disrupts the forcefulness of stimulus qualities thereby allowing individuals to bring a wider range of contexts and considerations to bear on the problem situation (Zelazo, 2004).

To summarize, response inhibition supports ER by inhibiting prepotent emotional responses and by generating psychological distance between emotional stimuli and emotional responses. The processes of psychological distancing and inhibiting prepotent responses likely operate together. That is, the ability to step back and reflect on a course

of action implies a sort of acquired neutrality in which the meaning of emotional stimuli remains undecided for the most part (Gehlen, 1988). As Gehlen aptly states, “this is how man masters the overwhelming barrage of impressions, this is how he obtains relief: He *actively ‘checkmates’ the forcefulness of the world’s impressions, making the world potentially available at any time*” (pp. 162-163, emphasis in original).

ER-delay inhibition. Delay inhibition may contribute to ER by making self-control less frustrating. Studies by Mischel and colleagues (Mischel et al., 1989; see also Vaughn et al., 1986) have suggested that children who spontaneously employ waiting strategies and those who direct their attention away from the target (especially the appetitive aspects of the target) achieve better immediate and long-term self-regulatory outcomes. Delay strategies “cool down” the problem space by “translating” affective problems into cognitive problems, and this transformation may make the problem easier to solve (Giesbrecht, Müller, & Miller, in press). This proposal is strengthened by recent research demonstrating that children’s performance on cool (i.e., cognitive) versions of tasks is generally superior to their performance on “hot” (i.e. affective) versions of the same tasks (Talwar, Carlson, & Lee, 2008). In addition, several studies have demonstrated that infants and children with better attentional control also tend to have better ER (Fox & Calkins, 2003; Morales et al., 2005). Taken together, these findings suggest that developing attentional control abilities and learning to use waiting strategies may be an important part of competent ER.

The finding that response and delay inhibition independently contribute to ER suggests that there may be multiple mechanisms whereby inhibitory control influences ER. The correlational design of this study, however, does not lend itself to sorting out

the possibilities raised by this finding. Given that the relation between inhibitory control and ER has now been replicated a number of times, future research should address the underlying processes by which inhibitory control and ER are related.

ER-WM/Flexibility. Previous studies have focussed on the relations between ER and the inhibitory control aspect of EF, thus leaving open the possibility that other aspects of EF may also be related to ER. In this study, measures with strong operational components (i.e., representational flexibility and updating/working memory) were also included. WM/Flexibility was positively related to children's use of negative emotion coping strategies in correlation analysis, however these findings were not replicated in the regression analysis after controlling for verbal ability and emotional reactivity. The evidence gathered here suggests that the relation between ER and EF is specific to inhibitory control.

ER-Social Understanding

This study found limited support for a link between ER and social understanding. Previous work in this area failed to find a link between cognitive social understanding (i.e., false belief understanding) and ER (Lieberman et al., 2007). This null result was replicated here; however, the inclusion of affective social understanding measures did yield significant results. It should be noted that measures of affective social understanding did not significantly predict ER when EF was included in the model. In addition, the nature and strength of the association between affective social understanding and ER varied markedly for different measures of ER. Accordingly, in the next section I first examine the relation between affective social understanding and child report and observational measure of ER and then parent-report measures of ER.

Observational and child report measures. Garner and Power (1986) reported that children's performance in the disappointing gift task was related to their ability to make inferences about other's emotions. Accordingly, it was expected that children's affective social understanding would also be related to performance in the disappointing gift task. Contrary to this expectation, affective social understanding was not related to regulation of either negative or positive emotion during the disappointing gift task ($r_s = .13$ and $-.05$ respectively, $p > .05$). However, affective social understanding was significantly related to children's report of negative emotion coping strategies, $r(127) = -.24, p < .05$. Garner and Power's findings indicated that better emotion understanding was related to the ability to activate positive emotion following a disappointing gift (i.e., to up-regulation positive emotion). In contrast, the present finding indicates that increases in affective social understanding were related to decreases in *negative* (i.e., inappropriate) emotional coping strategies. That is, as children's ability to discern other people's emotions increases, their tendencies to endorse socially inappropriate emotion coping strategies decreases. It may be that as children develop insights about other people's emotions, and in particular that other people may feel a different emotion from the one they display, they also develop insights about the ways in which they can acknowledge their own true feelings without needing to express them to the full extent of their experience. In other words, they develop the skill to dissemble the expression of these feelings to make them more socially acceptable. Indeed, research with adolescents has revealed that insights about emotion are related to ER (Ciarrochi, Chan, & Bajgar, 2001). Furthermore, accurate perception of emotional expression is related to social adjustment in young children (Cassidy, Parke, Butkovsky, & Braungart, 1992; Saarni, 1999). Cassidy et al.

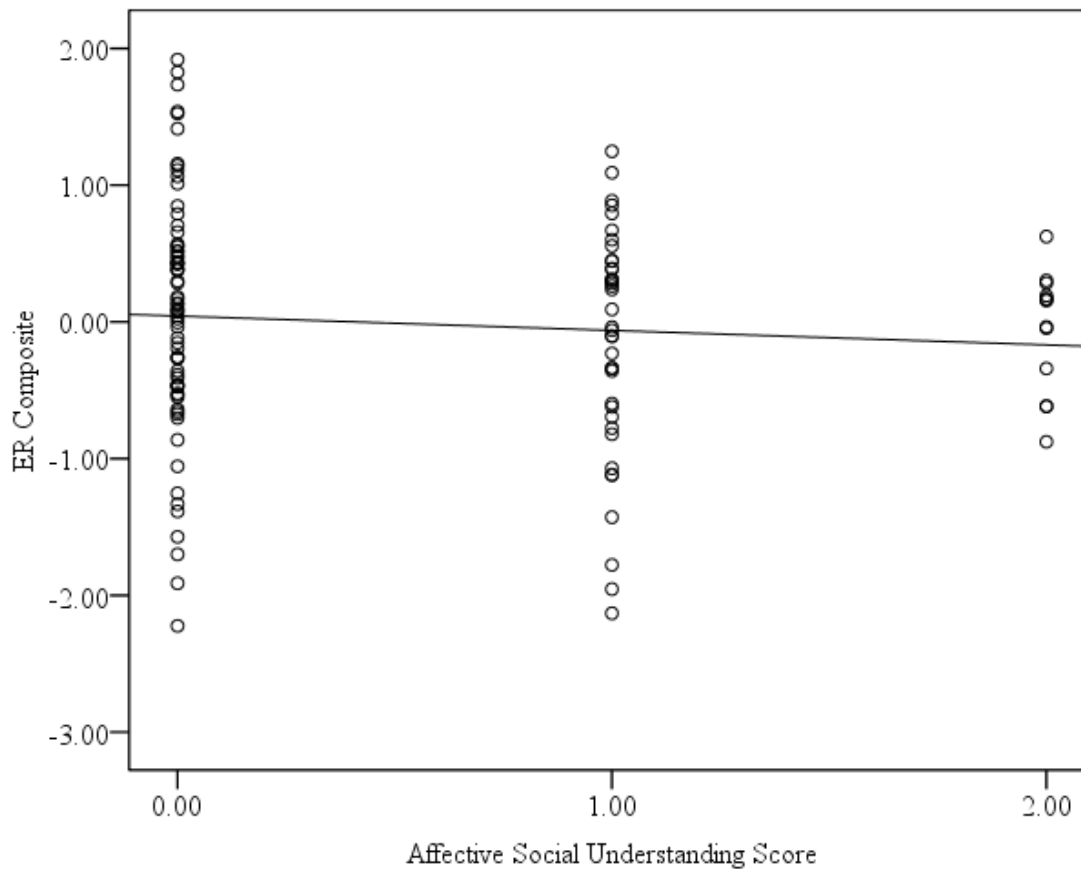
(1992) examined emotion perception and understanding in preschoolers by showing them photographs of people experiencing discreet emotions, and then asking them to identify the emotion being expressed, the nature of situations that may give rise to the emotion, and the appropriate responses to the emotion. They found that children who accurately perceived and understood emotions tended to receive higher peer acceptance ratings than their less emotionally astute peers. Observational studies of children interacting within classroom and playground settings suggest that accurately perceiving and modulating emotion plays a key role in peer victimization. For example, Wilton, Craig, and Pepler (2000) noted that accurately perceiving the emotional demands of peer interaction was a crucial determinant of the momentary escalation or de-escalation of the victim-bully exchange. Children who displayed emotional arousal through either venting or defensive aggression prolonged their engagement with the bully, while children who attenuated their emotional displays tended to de-escalate victimization episodes. Interestingly, failure to perceive and understand emotions may also perpetuate peer victimization when bullies believe that victims' deadpan emotional response indicates that they "didn't get the joke" (Cowie & Berdondini, 2002). These findings support the view that developments within affective social understanding facilitate socially adaptive ER.

Parent-report measures. It should be noted from the outset that parents are not dispassionate observers of their children. It is important to keep in mind that parent-report measures are an assessment of parent's perceptions of their children's regulatory functioning and not a direct measures of ER itself. Although parents provide valuable information about their children's behaviour, the ratings they provide are filtered through their idiosyncratic biases; biases which have not been measured here.

Contrary to expectation, parent-report ER and affective social understanding were inversely related in regression analysis. That is, children who performed well on the affective social understanding task received lower scores on the ER measure. This result contradicts the common sense hypothesis that better affective social understanding is related to better ER. The meaning of this result is not straightforward, therefore further analysis were conducted to understand the relation between ER and affective social understanding.

Eisenberg and Fabes (1992) have constructed a model of ER in which moderate levels of ER are seen as optimal because they avoid the extremes of highly inhibited and uninhibited behaviour. On the basis of this model, Eisenberg and Fabes predicted that the flexible use of ER (i.e. moderate levels of ER) would be associated with socially competent and constructive coping behaviours. Inasmuch as social competence and social understanding are related, the Eisenberg and Fabes model would predict that children with higher affective social understanding scores should have moderate levels of ER, whereas children with lower affective social understanding should have higher and lower ER scores. To explore this possibility, parent-rated ER was compared to different levels of performance on the affective social understanding tasks. Figure 3 displays a bivariate plot comparing the ER scores of children who passed none, one, or both of the affective social understanding tasks. The plot reveals that individual differences in ER *decrease* with better performance on the affective social understanding measure. In other words, children who were able to distinguish real from apparent emotion tended to have moderate ER scores that were tightly clustered near the middle of the overall distribution whereas children who performed poorly on the real-apparent emotion task displayed a

Figure 3. Bivariate plot of parent-report ER and children passing 0, 1, or 2 affective social understanding tasks



Notes: Higher scores on the ER composite indicate better regulation. The line represent the bivariate linear trend, $r(127) = -.09$, $p = .32$.

wide range of scores. This seems to suggest that as children's affective social understanding matures, they display more moderate levels of ER. Within the Eisenberg and Fabes model, this evidence suggests that ER becomes more flexible and optimal. In support of this conclusion, other researchers have suggested that social experience and understanding generally have a salutary effect on the development of self-regulation (Kopp, 1989; Perner & Lang, 1999).

Several caveats apply to the interpretation of these results. First, the bivariate correlation between parent-report ER and affective social understanding was not significant, $r(127) = -.09, p = .32$. Second, within the regression analysis, the incremental contribution of affective social understanding to predicting ER was very small, $\Delta R^2 = .02$. Finally, relatively few children passed both affective social understanding tasks; therefore smaller sample size in this group may have contributed to decreased variability in the scores.

Overall, the findings reported here suggest that ER is more strongly related to understanding emotion than understanding (false) belief. Future studies should extend these findings by including diverse measures of affective social understanding as well as diverse measures of ER. Examining association between social understanding and the interaction between ER and emotional reactivity may also be a fruitful endeavour for future research because aspects of social understanding were also related to emotional reactivity in this study.

Summary of Findings on the Relation between ER-EF and Social Understanding

The overall conclusion that can be drawn from regression analyses predicting ER from EF and social understanding is that the relation between ER and other aspects of self-regulation is limited to specific aspects of EF and social understanding. In particular, only inhibitory control and affective social understanding were significantly related to ER. Regression models that included both EF and social understanding variables revealed that inhibitory control is related to ER even after controlling for other aspects of self-regulation, whereas the relation between affective social understanding and ER did not remain significant when other aspects of self-regulation were included in the model.

These findings suggest there is a unique relation between inhibitory control and ER, whereas the relation between ER and affective social understanding significantly overlaps with the relation between ER and other aspects of self-regulation.

If the finding of a limited relation between EF and ER holds up in further studies, then this may challenge the model of cognitive-emotion interaction recently proposed by Zelazo and Cunningham (2007). According to this model, EF and ER are largely overlapping abilities but the nature of the interaction between them depends on the problem solving context. When the problem to be solved is primarily emotional, then EF and ER are isomorphic. When the regulation of emotion is necessary but secondary to the problem to be solved, then EF is thought to involve ER. Findings from this study suggest that ER and aspects of EF are related but unique processes. It should be noted, however, that this study represents a weak test of the Zelazo and Cunningham model. Stronger tests could be produced by designing studies that measure EF within emotionally challenging tasks.

The Problem of Coherence in ER Measures

There was limited evidence for coherence among measures of ER in this study. Although previous studies have reported similar results lacking in coherence, the theoretical and measurement issues raised by these findings have generally not been addressed. Doing so is an important task for advancing the field of ER research. Three aspects of this problem are therefore examined here: multiple-informant coherence, within-context coherence, and cross-context coherence.

The problem of multiple-informant coherence is not unique to emotion research. Temperament researchers, for example, have consistently observed that correlations

between parent-report and observational measures of temperament hover around .2 when they are significant (for reviews, see Kagan, 2007; Seifer & Sameroff, 1986). Some have interpreted such poor cross-informant convergence as evidence that parents are unreliable reporters of their children's behaviour (Seifer, Sameroff, Barrett, & Krafchuk, 1994). For various reasons, including the stability of parental temperament ratings over time, such a conclusion is probably not warranted. However, low parent-report and observational correlations do indicate that these measures are not alternate forms of the same assessment instrument. In this study, an additional challenge arises from the finding that parent-report and observational measures sometimes led to opposite conclusions about children's rank order within the distribution of ER abilities.

One of the reasons for this apparent disagreement between different measures of ER has to do with the different sources of information that parents and observers use to evaluate ER. Parents observe their children in a wide variety of contexts, including novel and challenging situations in which children's regulatory abilities may be readily observable. In contrast, researchers can create opportunities to observe children's behaviours in standardized situations (which make comparisons between children more meaningful) but these observations are limited to small samples of behaviour over short periods of time in which the presence of the researcher may influence children's behaviour. Parent-report and observational measures may therefore provide information about different aspects of child functioning. The problem of multiple informant coherence is also related to problems of contextual coherence.

The problem of contextual coherence challenges current conceptualizations of ER as a stable characteristic of the individual. Two aspects of contextual coherence inform

this discussion. First, different indices of emotion and ER display poor coherence within a single situation. For example, in the present study, six different indicators of negative emotion were assessed in the disappointing gift task: negative facial expression, intensity of negative facial expression, negative verbalizations, response to the question about liking the gift, tone voice in response to the question about liking the gift, actions toward the disappointing gift, and actions toward the experimenter. The average correlation between these different indicators was .14. According to Campos et al. (2004), however, low correlations between different indicators of ER should be expected. Drawing on research using the visual cliff paradigm and the strange situation paradigm, they argue that apparent inconsistencies can be resolved when researchers focus on the organization of emotional behaviours rather than the mere occurrence of these behaviours. The value of taking an organizational approach to emotional behaviour is exemplified by the germinal work of Sroufe and Waters (1977), whose reconceptualization of attachment behaviour reinvigorated attachment research. The problem of within context coherence in ER research will benefit from applying the lessons learned by attachment researchers. For example, future research should focus on establishing the functional equivalence of different regulatory behaviours so that classes of behaviours can be defined. One would expect coherence among behaviours within a class, but not necessarily between two different classes. Another approach is to shift focus from quantitative differences among ER behaviours to the qualitative differences between different constellations of ER behaviours. An example of this kind of approach can be found in the work of Mary Ainsworth (Ainsworth, Blehar, Waters, & Wall, 1978) where the focus is on the quality of attachment, not the absolute amount of behaviours.

The second aspect of the contextual coherence problem has to do with cross situational coherence. The implicit assumption in much ER research is that poor coherence across situations reflects noise and error of measurement. The typical solution is to measure ER in several situations and then aggregate across these situations, assuming that different measures converge, to a greater or lesser extent, upon an underlying construct. Although such aggregate information reveals that, on the whole, individuals differ in emotional behaviour and regulation, it glosses over the variability in behaviour across situations. A different approach to this problem is to incorporate situational variables into the search for coherence by examining factors that may contribute to individual consistency over time within individual variability across situations. Research by both Mischel (2004) and Siegler (1996) has emphasized the role of variability in the development of children's problem solving. An example of this kind of approach to ER comes from a study using the disappointing gift paradigm where the presence or absence of an adult significantly influenced children's regulatory behaviours (Cole, Zahn-Waxler, & Smith, 1994). Assuming that patterns of variability from one situation to another are not entirely random, including information about variability in assessments of ER may help to establish individual consistency within individual variability (for discussion of this approach see Mischel, 2004). Examples of factors that may moderate ER performance include novelty of the situation or stimulus, presence or absence of others, the quality of the relationship between the child and the other who is present, the child's mood prior to engaging in the ER task, the temperament, age, and sex of the child. Incorporating knowledge about situational factors into models of ER is likely to lead toward coherent but qualified accounts of ER. However, one of the

important tasks for future research will be to determine whether stable patterns can be detected within patterns of variability.

Questions about the coherence of ER measures strike at the very heart of ER research because they raise fundamental questions about the nature of ER. Although much research assumes that ER is a characteristic that different individuals possess in different amounts, an alternate approach is to view ER as a conceptual rubric for understanding and organizing a set of interrelated behaviours (Thompson, 1994).

Establishing a coherent measurement framework for ER remains an important task for the development of emotion research (Giesbrecht, 2007).

Relations between ER, Sex and Age

Although older children and girls are often expected to perform better on measures of ER, studies using the disappointing gift task have reported mixed results. In studies with preschoolers, some researchers have found sex differences (Carlson & Wang, 2007; Cole, 1986) while others have not (Kieras et al., 2005; Lieberman et al., 2007). Likewise, some studies have reported age differences (Carlson & Wang; Liebermann et al.) while others have not (Kieras et al.). Saarni (1984) reported an age by sex interaction in a group of 1st-, 3rd-, and 5th-grade children. Interestingly, Saarni found that the oldest and youngest boys displayed the most negativity.

The results reported here do not clarify the overall understanding of sex and age differences in ER. Some analyses did produce sex differences while others did not. Sex differences, for example, were found for parent-report ER and for observational measures of ER within the subsample of children high or low in ER. In both cases, being female was associated with better ER performance. While Cole (1986) reported a similar result,

Carlson and Wang (2007) found that boys demonstrated better ER when asked if they liked their disappointing gift. Both of these studies employed measures and procedures similar to the ones used here. Sex differences were not found, however, for observational measures of ER when the entire sample was included, nor were sex differences observed for temper tantrums. The inconsistent pattern of results both within the present study and across previous studies suggest that sex differences in ER may be sensitive to sample characteristics or minor differences in procedures that are not well understood. It should be noted that two male testers assessed children in this study and this may have influenced the manner in which children responded, especially on the Gift Delay task. Previous studies have employed female testers. In addition, the two male testers each administered the same set of tasks (i.e., session A or session B) to the children, and this may have influenced the results.

One limitation of this analysis that should be kept in mind is that results from the logistic regression analysis may not generalize to all typically developing children. Recall that only a subsample of children with extreme scores was selected for this analysis. This strategy has been used by other researchers to deal with problems of coherence (e.g., Fish, Stifter, & Belsky, 1991). Kagan (2007), however, notes that children selected through such procedures probably belong to a special category that is not representative of the entire range of scores on a measure. In other words, subsamples of extreme scores probably only represent children who are extreme. The generalizability of these results, therefore, is limited to those children who are consistent across contexts. As noted previously in the discussion of coherence, children selected through such procedures may respond similarly to different situations because, for them,

those situations have equivalent meaning. Unfortunately, the design of this study did not lend itself to exploring factors that may contribute to the consistency in the behaviour of some children. Determining the basis on which different situations have equivalent meaning for different children is an important topic for future research.

Likewise, with regard to age, the results reported here demonstrate no clear developmental pattern. In regression analysis, age was a significant predictor for parent-reported ER but not for observational measures. Children's performance on the Disappointing Gift task exemplified the complexity of relations between ER and age. On this task, older children demonstrated *more* negativity, but older and younger children did not differ in terms of positivity. Similar results were reported by Saarni (1984), who found that both younger (grade 1) and older (grade 5) boys demonstrated more negativity than their grade 3 peers. The reasons for this U-shaped developmental pattern are not clear. Instances of apparent regression abound in the developmental literature and a number of proposals have been made to account for this interesting phenomenon (Siegler, 2004). It should be noted that this study, like other studies reporting a U-shaped trend in ER, used a cross-sectional research design. Longitudinal research is needed to adequately assess for the presence of U-shaped developmental patterns.

Another limitation of this study is that it focuses only on the down-regulation of negative emotion. Although the attenuation of negativity is an important clinical consideration, the up-regulation of both positive and negative emotion also has useful clinical and theoretical implications. For example, understanding the relation between the up-regulation of positive emotion and EF may provide insight into the cognitive difficulties of depressed children.

Temper Tantrums and Self-Regulation

In general, results from the analyses of temper tantrums confirm that ER is an important component of tantrum control. ER remained a significant predictor of temper tantrums even after controlling for age, verbal ability, emotional reactivity, and inhibitory control, suggesting that the relation is robust. ER was also a significant mediator of the relation between emotional reactivity and temper tantrums, further supporting the conclusion that advances in ER contribute to declines in temper tantrums.

In contrast to the robust relation between ER and temper tantrums, EF and social understanding exhibited weak and contradictory relations with temper tantrums. No meaningful pattern of relations could be detected between temper tantrums and the EF and social understanding variables, with the exception of delay inhibition, which was a marginally significant predictor in the regression analysis. These findings do not support a model in which diverse aspects of self regulation contribute to individual differences in temper tantrums. Instead, the relation between temper tantrums and self-regulation appears to be restricted to inhibitory control and ER.

These exploratory analyses of temper tantrum make several contributions to understanding the nature of the relations among aspects of self-regulation in typically developing preschoolers. First, the significant relation between temperament and temper tantrums is a new finding. As expected, children who were more emotionally reactive were also more active tantrummers. To the extent that tantrums represent a failure of self-regulation, these findings suggest that temperament plays an important role in the development of self-regulation. Second, the significant relation between delay inhibition and temper tantrums in regression analysis suggests that increases in frustration tolerance

may be an important component of declines in temper tantrums. As argued previously, delay inhibition may contribute to decreases in temper tantrums by making self-regulation less frustrating. This suggestion is strengthened by the fact that delay inhibition remained a significant predictor of temper tantrums, even after controlling for emotional reactivity. Third, the significant relation between temper tantrums and ER, after controlling for age, verbal ability, emotional reactivity, and delay inhibition provides evidence that ER is a robust predictor of temper tantrums. It should be noted, however, that the effect sizes for delay inhibition ($R^2 = .022$) and ER ($R^2 = .034$) were small, accounting for 2.2 and 3.4 percent of the variance in temper tantrum scores, respectively. Finally, the intervening role that ER plays in the relation between emotional reactivity and temper tantrums highlights the importance of both activation and regulation systems in the understanding of temper tantrums. The basic idea underlying the mediation hypothesis was that ER would attenuate the influence of emotional reactivity on emotional behaviours. The results of the mediation analysis support the hypothesis that ER significantly buffers the effect of negative reactivity on temper tantrums.

Some limitations of these results should be taken into consideration. The primary limitation is that a constrained set of variables were used in the temper tantrum analyses. There were several reasons for this. First, only parent-report measures could be used in the mediation analysis because only parent-report measures were significantly related to temper tantrums. Although it may be reasonable to conduct mediation analysis when the independent variable (i.e., emotional reactivity) and the dependent variable (i.e., temper tantrums) are unrelated, it is not reasonable to do so when the independent and dependent

variables are unrelated to the proposed mediator. As a result of this constraint, and the lack of significant correlations between observational measures of ER and emotional reactivity, mediation analysis was conducted only for parent-report measures. Results that depend on a single source of information, however, require replication with other sources of information because the reported relations may result from the common source of the ratings. Given that temper tantrums, during the preschool years, are primarily a phenomenon that occurs in the presence of parents, future studies should focus on improving the reliability and validity of these parent-report measures. Doing so may generate stronger relations with observational measures of emotional behaviour, which could then be used to replicate this mediation analysis.

A second reason for using a constrained set of variables in the temper tantrum analysis was that patterns of correlations between parent-report of temper tantrums and child-report and observational measures of self-regulation were difficult to interpret. In many cases, the trend for these correlations were opposite of what was expected. For example, the trend between WM/Flexibility and temper tantrums was positive, suggesting that children with more advanced representational flexibility also display more frequent and more intense temper tantrums. These results are difficult to interpret within the model of self-regulation adopted here, where advances in self-regulatory abilities are believed to be associated with declines in temper tantrums. One explanation for these unexpected results is that the development of more advanced self-regulatory processes may result not only in overall improvements in self-regulatory performance but also in a rise of specific (and limited) problem behaviours, such as temper tantrums. Longitudinal

studies are required to determine if advances in some aspects of self-regulation temporarily contribute to increases in temper tantrums.

Relations between Verbal Ability, ER and Temper Tantrums

Verbal ability was not a significant predictor of ER or temper tantrums in any of the regression analyses this study. Several zero order correlations between verbal ability and self-regulation measures, however, were significant. In contrast to previous studies that did not find a relation between verbal ability and the display of negative emotion following a disappointing gift (Liebermann et al., 2007; Carlson & Wang, 2007), the findings here suggested that children with better verbal ability had *worse* ER than their less verbal peers, $r(127) = .20, p < .05$. This finding is opposite to what was expected. Verbal ability was also related to child report of negative coping strategies in emotionally negative situations, $r(127) = -.23, p < .01$. This finding was in the expected direction. Children with poor coping strategies also scored low on the verbal ability measure. Neither of these results, however, remained significant after controlling for age.

The null results with regard to the lack of unique association between verbal ability and self-regulation of emotion were surprising for several reasons. First, language is believed to function as a general developmental mechanism that contributes to the emergence of self-regulation. Kopp (1989) suggests that language offers young children a “multipurpose vehicle” for regulating emotions. The emergence of new language abilities has been proposed as a reason for the developmental decrease in crying in the third year (Kopp, 1992). In addition, language may play a role in both the formation and the implementation of self-regulatory abilities by allowing children to reflect on their emotional experience (Müller et al., in press). This reflection, in turn, provides the tools

for generating and implementing self-regulatory strategies. Given that language facilitates both awareness of emotional experience and a means by which those experiences may be transformed by the self-regulatory goals of the individual, the lack of association between verbal ability and ER is puzzling.

Second, beyond the more general developmental interdependence of language and ER, limitations in verbal ability have been implicated in the occurrence of temper tantrums. This explanation draws on the developmental lag between language skills and socio-affective growth (Leach, 1997). According to the language hypothesis (Bath, 1994), young children lack the skills to express their own feelings or to ask for something they want. The resulting frustration and anger are expressed in a tantrum outburst (Buxbaum, 1981). In support of this hypothesis, temper tantrums, and behaviour problems more generally, tend to be more common in preschool children with speech and language delay (Jenkins, Bax, & Hart, 1980). On the other hand, children with selective language impairments sometimes have difficulty up-regulating their emotional arousal (Fujiki et al., 2004), suggesting that they may be emotionally overcontrolled. Although the language hypothesis has been promoted in the therapeutic literature, this study does not support it.

Several limitations to the current study warrant a cautionary note regarding the finding of no relation between language and control of emotion. First, the PPVT-III is a measure of *receptive* vocabulary, not *expressive* vocabulary. It may be the case that temper tantrums, and ER more generally, are related to *expressive* verbal ability and not *receptive* verbal ability. The language hypothesis suggests that it is primarily the inability to express desire and emotion that lead to frustration, although an inability to

understand reasoning may also contribute (Bath, 1994). Future studies should examine this issue by including measures of expressive vocabulary. Tomblin and Zhang (2006), however, have suggested that, despite the purported distinction between them, measures of expressive and receptive vocabulary do not provide differential information about language abilities in young children. According to these researchers, language, as measured and represented in commonly available tests, can be thought of predominantly as a single trait, particularly in the preschool and early school years. Nonetheless, the relation between language abilities and ER is inherently interesting, and future research should include a multidimensional measure of language. The second limitation is that these results may not apply to atypically developing children or those with severe temper tantrums. Children with severe temper tantrums may represent a developmentally distinct group of children because they experience comorbid disorders of childhood at a much higher rate than children without severe tantrums (Needlman, Stevenson, & Zuckerman, 1991). Future studies could clarify these questions by including language as a moderator of tantrum severity. Such research may reveal that language is related to temper tantrums only for severe tantrummers, or only for children very low in language ability.

Missing Data

Although the amount of missing data in this study was small, missing values were seen as a significant problem because they were systematically related to children's refusal to complete study tasks. Exploratory analysis revealed that, contrary to expectation, refusals were related only to verbal ability, and not to self-regulation variables. Nevertheless, data imputation procedures were preferable to listwise deletion

in this sample because: (a) listwise deletion results in a reduced sample that differs in unknown ways from the sample described in the methods section, (b) reduced sample size results in decreased power to detect small effects, and (c) by incorporating frequency of refusal in the maximum likelihood estimation of missing values, a presumed cause of missingness could be included in data imputation. More sophisticated data imputation procedures are currently available (e.g., multiple imputation), however the single imputation procedure used here struck a balance between simplicity and rigour. It should be noted that all of the analyses reported here were also conducted using listwise deletion. In all cases, the results led to the same conclusions about the associations between variables. Effect sizes were also similar when comparing the results from the EM and listwise deletion analyses.

Suggestions for Future Research

Some directions for future research have already been noted. The issue of coherence among measures of ER presents a significant challenge for future research. Documenting the factors that influence consistency and change within and across contexts will help to distinguish between developmental and temporary changes in ER. Some examples of research that have systematically examined situational variables that influence ER have already been noted. More studies examining both the internal (i.e., within child) and external moderators of ER are needed to understand the organization of regulatory behaviours.

An additional consideration for future research is the possibility that current research paradigms used with preschoolers do not effect sufficient emotional activation from which to measure ER. It is possible that the problem of coherence among measures

of ER derives, in part, from the mildness of the stress induced by the ER tasks. Studies with infants and toddlers tend to use stronger manipulations (i.e., arm restraint) that often result in more intense emotional reactions. It is interesting that procedures employing these strong manipulations are more acceptable when used with infants, whereas manipulations with older children are often geared toward more subtle and less provocative emotional challenge. The disappointing gift and gift delay paradigms are examples of mildly stressful situations. One of the challenges for future research will be to identify measures that are both strong manipulations and ethically acceptable. Opportunities for observational measurement of naturally occurring strong emotion abound within the home and school settings. Conducting research within home or school settings, however, is labour intensive and requires special consideration for standardizing observations. Examples of successful approaches to this kind of research can be found in Wilton, Craig, and Pepler (2000), who provide a compelling account of children's ER during episodes of bullying. The rewards of such research, however, are likely to outweigh their costs.

The current study also points toward the need to better understand the processes underlying the organization of self-regulation. Aspects of EF and social understanding were examined in relation to ER; however there may be other psychological constructs that shed light on the organization and development of ER. For example, how might changes in the development of self, self-esteem, and a sense of personal agency influence changes in ER? Culture was highlighted in the conceptual model proposed in the introduction, but was not examined here. Understanding how broad cultural factors as well as local family factors (i.e., parenting) influence the development of ER remains a

largely unexamined topic. More studies with longitudinal designs are needed to address questions about the organization and development of ER.

This study suggested that better understanding of temper tantrums may shed light on the changes in self-regulation that occur during the preschool years. Given that most children between the ages of 3 and 5 displayed tantrums, this age range appeared to be ideal for examining tantrums in typically developing children. It will be useful in future research to also include younger and older children in order to understand how and when tantrums come “online” and how and when tantrums decline. In addition, it may be useful to study older samples of children to understand what factors may contribute to children retaining tantrum behaviours past developmentally appropriate ages. Little is known about the individual developmental trajectories of temper tantrums and how individual differences might influence these trajectories. Longitudinal studies that employ multilevel modeling approaches could address these questions.

This study examined general questions about the relation between temper tantrums and self-regulation. Given that increases in ER and inhibitory control may be fundamental processes for declines in temper tantrums, it will be useful to examine these processes in more depth to understand the mechanisms whereby self-regulation and temper tantrums are connected. Typically developing children eventually “give up” tantrum behaviour in favour of more socially acceptable and effective coping strategies, but little is known about the mechanisms that facilitate this transition.

Although it is reasonable to assume there is a causal direction from self-regulation to temper tantrums, there may be reasons to believe that temper tantrums also have positive causal influence on the development of self-regulation. This counterintuitive

notion comes from the proposal that temper tantrums may aid children in establishing a sense of individuality (Proffer, 1995). Cross-lag research designs that investigate transactions between temper tantrums and self-regulation over time may shed light on this interesting question.

Related to the issue of what processes lead to the cessation of temper tantrums is the question of what function temper tantrums serve in the emotional development of children. Are temper tantrums primarily an expressive behaviour, an instrumental behaviour, or both? The perspective taken here was that temper tantrums represent a failure of ER. This assumption was supported by the finding of a significant relation between ER and temper tantrums. It is possible, however, that temper tantrums may also serve an instrumental purpose for some children. That is, whereas some children tantrum because they are not capable of dealing with the overwhelming frustration they feel, other children may tantrum because there is some payoff for doing so. Such a distinction may parallel the distinction aggression researchers have drawn between reactive and proactive aggression (Crick & Dodge, 1996). One of the ways to assess the degree to which temper tantrums are instrumental is to investigate the contingent responses of parents and siblings to them. Acquiescence and anger from observers, for example, may be associated with instrumental tantrums while comforting and firmness may be associated with expressive tantrums.

Finally, this study highlights the need to continue investigations of the relations among aspects of self-regulation. The organization of self-regulation in early childhood, and in particular the integration of cognitive, social, and emotional aspects of self-regulation, has important implications for our understanding of the processes by which

children transcend the world of stimulus-response to exercise choice, make decisions, and plan their actions.

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Appendix A: Temper Tantrum Grid

Young children sometimes respond to frustration, limitations, or requests with temper tantrums. We would like to know how often and how intense your child's temper tantrums have been in the past month.

Instructions: As you think about your child's temper tantrums, try to include only those times when you are sure that your child is feeling a strong emotion (for example, you can see the emotion on her/his face) and s/he is also displaying behaviours like crying, screaming, falling to the floor, etc. Do not include times when your child is reacting to an injury (for example, falling off a bike), reacting in fear (for example, fear of a dog), squabbling with siblings (if squabbling turns into a tantrum then include the tantrum but not the squabbling), or times when s/he looks you in the eye and disobeys you (for example, defiance).

Appendix A Cont.

In the table below, please circle the number that shows how often and how intense each physical reaction and behavior was **during tantrums** in the past month.

	FREQUENCY					INTENSITY			
	Never	Seldom	Some of the Time	Often	All of the Time	Little or None	Mild	Moderate	Severe
PHYSICAL REACTION									
Cry tears	1	2	3	4	5	1	2	3	4
Turn red	1	2	3	4	5	1	2	3	4
Drool or nose run	1	2	3	4	5	1	2	3	4
Cough, gag, pant, hiccup	1	2	3	4	5	1	2	3	4
BEHAVIOR									
Cry	1	2	3	4	5	1	2	3	4
Whine	1	2	3	4	5	1	2	3	4
Comfort self	1	2	3	4	5	1	2	3	4
Come to parent for comfort	1	2	3	4	5	1	2	3	4
Yell words	1	2	3	4	5	1	2	3	4
Scream at high pitch	1	2	3	4	5	1	2	3	4
Flap hands	1	2	3	4	5	1	2	3	4
Throw things	1	2	3	4	5	1	2	3	4
Run/walk away	1	2	3	4	5	1	2	3	4
Hit	1	2	3	4	5	1	2	3	4
Stamp	1	2	3	4	5	1	2	3	4
Kick	1	2	3	4	5	1	2	3	4
Lie, sit, kneel or throw self on floor	1	2	3	4	5	1	2	3	4
Grab/push things or slam doors	1	2	3	4	5	1	2	3	4