

Sustained Attention Development during the Toddlerhood to Preschool Period: Associations with Toddlers' Emotion Regulation Strategies and Maternal Behaviour

Paulo A. Graziano^{a,*}, Susan D. Calkins^b and Susan P. Keane^c

^aCenter for Children and Families, Department of Psychology, Florida International University, Miami, FL, USA

^bDepartment of Human Development and Family Studies and Psychology, University of North Carolina at Greensboro, Greensboro, NC, USA

^cDepartment of Psychology, University of North Carolina at Greensboro, Greensboro, NC, USA

The current study examined the role of maternal behaviour and toddlers' emotion regulation strategies in the development of children's sustained attention abilities. Participants for this study included 447 children (232 girls) obtained from three different cohorts participating in a larger ongoing longitudinal study. When the children were 2 years of age, mothers brought their children to the laboratory and were videotaped during several tasks designed to elicit emotion regulation and mother–child interaction. Sustained attention was also measured at the same visit via a laboratory task and in a subsequent visit when children were 4.5 years of age. Results indicated that toddlers' use of help-seeking emotion regulation strategies was positively related to sustained attention, while avoidance behaviours and maternal behaviour characterized by high levels of overcontrolling/intrusiveness were negatively related to sustained attention at age 2. Significant interactions emerged such that high levels of maternal warmth/responsiveness buffered the negative associations between low use of distraction and high use of self-comforting emotion regulation strategies and sustained attention at age 2. Maternal behaviour characterized by high levels of

*Correspondence to: Paulo A. Graziano, Center for Children and Families & Department of Psychology, Florida International University, 11200 SW 8th Street, HLS 1 Rm. 235A, Miami, FL 33199, USA. E-mail: pgrazian@fiu.edu

warmth/responsiveness also predicted greater growth in sustained attention from age 2 to 4.5. These findings are discussed in terms of how maternal behaviours and children's use of active versus passive emotion regulation strategies relate to sustained attention abilities. Copyright © 2011 John Wiley & Sons, Ltd.

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Research on the development of attentional abilities differentiates between three attentional systems (Rueda, Posner, & Rothbart, 2005). The first system emerges at birth and involves the most basic aspect of attention: alerting, or the state of wakefulness and arousal of the infant. Almost immediately after birth the second system emerges as infants gain the ability to orient. The ability to orient matures rapidly within the first 6 months indicating an ability to select information from sensory input (Posner, 2004). This ability to select information from sensory input allows infants to not only orient to their environment but also to track such stimuli (Colombo, 2004). The third attentional system develops towards the end of the second year and is referred to as the executive control of attention. It is referred to as executive attention or attentional control because the organism is now taking voluntary control of his/her attention to resolve conflicts among thoughts, feelings, or behaviours (Rueda *et al.*, 2005). An important component involved in the development of this third, more effortful, attentional system is sustained attention, or an individual's ability to maintain his or her focus on a specific stimulus (Fuentes, 2004; Ruff & Rothbart, 1996).

Ruff and Rothbart (1996) further differentiate focused or sustained attention from casual attention by emphasizing that focused attention entails sustained and active engagement with a stimulus or task. Learning is also more likely and distractions are less likely to occur during periods of sustained attention versus more casual attention. Measurement of sustained attention can subsequently be conducted via behavioural or physiological means. Within the physiological domain, significant research has shown that sustained attention, and enhanced information processing, is associated with a sustained decrease in heart rate and heart rate variability (Lansink & Richards, 1997; Richards & Casey, 1991). Within the behavioural domain, and of interest to the current study, sustained attention is typically measured via the length of time that children spend visually attending to and engaged with a specific task or stimulus (Gaertner, Spinrad, & Eisenberg, 2008).

Looking durations during infancy have been used to examine habituation and information processing to novel stimuli with shorter looking periods generally associated with higher levels of cognitive processing (see Colombo, 1993 for a review). However, by 18 months and with the emergence of the third and more effortful executive attentional system, longer looking periods are associated with increased sustained attention (Ruff & Capozzoli, 2003; Ruff & Lawson, 1990). There is also significant variability in terms of which tasks researchers use to examine behavioural indices of sustained attention ranging from structured to unstructured play, problem-solving, mother-child interactions, and novel toys (Gaertner *et al.*, 2008; Ruff & Lawson, 1990; Ruff & Capozzoli, 2003). More recent research has indicated that the use of more complex and/or interactive stimuli such as video clips, compared to more traditional habituation paradigms that use more static, achromatic materials, provides a better opportunity to examine change in toddlers' sustained attention abilities with increases in look duration

observed as children get older (see Courage, Reynolds, & Richards, 2006; Richards & Anderson, 2004 for a review). Regardless of how one measures sustained attention, it is clear that sustained attention plays a key role in the normative development of children's cognitive, emotional, and psychological functioning.

Impairment in sustained attention abilities has been observed in various clinical groups, including children with Attention-Deficit/Hyperactivity Disorder (ADHD), pervasive developmental disorder, conduct disorder, mood and anxiety disorders, and psychotic symptoms (Pennington & Ozonoff, 1996; Swaab-Barneveld *et al.*, 2000). In addition to its association with cognitive functioning and school performance (NICHD Early Child Care Research Network, 2005), deficits in sustained attention are also predictive of worse social outcomes (Andrade, Brodeur, Waschbusch, Stewart, & McGee, 2009; Murphy, Laurie-Rose, Brinkman, & McNamara, 2007). Deficits in childhood sustained attention abilities also appear to be chronic in nature as they have been found to be associated with similar attentional deficits in adolescents and adulthood (Biederman *et al.*, 1998, 2007) and similar negative consequences, including risky health behaviours, social deficits, and occupational impairments (Barkley, 2002; Fischer, Barkley, Smallish, & Fletcher, 2007; Molina *et al.*, 2007).

Despite the well-established negative consequences of sustained attention deficits, there remains a scarcity of research examining the development of sustained attention in non-clinical samples (Betts, McKay, Maruff, & Anderson, 2006; NICHD Early Child Care Research Network, 2005). Theoretical and neuropsychological data indicate that attention development is a result of not only brain maturation, specifically the anterior cingulate cortex (ACC), but also an increase in social interactions with the caretaker and the emergence of language (Posner, 2004). Past developmental research particularly focused on the gradual shift from subcortical processing to increasing cortical control over attention (Colombo, 2004; Posner, 2004). However, the bulk of such research has focused on the infancy period and the examination of early orienting and selective attention skills (Colombo, 2004) or the development of executive attentional skills (i.e. attentional control) in early and late childhood (Espy, Kaufmann, McDiarmid, & Glisky, 1999; Kochanska, Murray, & Harlan, 2000; Zhou *et al.*, 2007). Thus, there remains a crucial gap in our understanding of the development of sustained attention skills and what contributes to individual differences in such development (Blair, 2002).

A large portion of the variability in children's sustained attention development has been attributed to genetics as reported in the ADHD literature (Barkley, 1997) as well as in the genetic disorders (e.g. Fragile X) literature (Loesch *et al.*, 2003). However, despite the strong genetic link, there remains a host of other factors that have been shown to be related to normative development of sustained attention, including child factors (e.g. gender, language, temperament), parenting factors (e.g. maternal psychopathology, maternal speech, attachment, maternal behaviours), and socioeconomic factors (e.g. poverty, neighborhood). The current study focused on two crucial factors—maternal behaviour and emotion regulation strategies—that may theoretically explain individual differences, above the effects of genetics, in the normative development of children's sustained attention.

Maternal behaviours play a significant role in the socialization of children's attentional abilities as well as other cognitive skills (Vygotsky, 1978; Wood & Middleton, 1975). Research has shown that during infancy joint attention is the primary socialization mechanism that parents engage in to promote their infants'

attentional abilities. Joint attention episodes involve parents following or redirecting the infant's visual attention during social interactions by asking questions, naming, describing features, and physically manipulating the object in order to encourage the infant's attention (Mundy & Newell, 2007). More general maternal behaviours indicative of emotional support such as the use of praise, display of warmth/positive affect, responsiveness and sensitivity, and taking the child's developmental level into consideration are also viewed as crucial scaffolding behaviours toward the development of attentional skills not only during infancy but as children get older (Landry, Miller-Loncar, Smith, & Swank, 2002). For example, the use of positive affect and warmth during play may stimulate children's interest in the task and subsequently refocus their attention. Children are also more motivated and likely to internalize their parents' values for desirable behaviour (e.g. paying attention) when their parents are positive and supportive (Dix, 1991; Grusec & Goodnow, 1994).

On the other hand, negative maternal behaviours that do not provide emotional support are also likely to affect children's attentional development. For example, harsh parenting behaviours, such as being hostile, punitive, and expressing high levels of negativity, are likely to produce high levels of stress and emotional overarousal in children, which may affect their ability to use higher-order cognitive skills, including sustained attention (Blair, 2002; Hoffman, 2000). The second and perhaps most important negative maternal behaviour to consider, given its negative influence on scaffolding, is maternal overcontrol which reflects excessive regulation of children's activities. This type of behaviour is also characterized by intrusiveness and use of excessive demands (Gilliom & Shaw, 2004). The excessive use of demands and re-directing without sensitivity to the child's cues may be particularly frustrating for toddlers who are beginning to engage in more autonomous behaviours (Calkins & Johnson, 1998). Maternal overcontrolling behaviour also interferes with a child's spontaneous engagement with a task and subsequent motivation to follow their natural interest (Ruff & Rothbart, 1996). From this perspective, an intrusive mother may distract a child from focusing on his or her task, which would in a sense take away that child's motivation to independently practice his or her sustained attention.

In addition to maternal behaviours, children's use of various emotion regulation strategies may also offer insight as to their level of attentional development. While the construct of emotion regulation is widely regarded as critical for children's adaptive functioning across a range of domains (Calkins, 2007; Eisenberg et al., 2009; Graziano, Reavis, Keane, & Calkins, 2007; Keenan, 2000; Rothbart & Bates, 2006), it is important to recognize the various strategies that children may partake in efforts to regulate affective arousal. Specifically, research has differentiated between more *active emotion regulation strategies* such as distraction or initiation of help-seeking behaviour compared to more *passive emotion regulation strategies* such as self-comforting (Buss & Goldsmith, 1998; Grolnick, Bridges, & Connell, 1996; Fox & Calkins, 2003). Active emotion regulation strategies rely more heavily on attentional control compared to more passive strategies, occur more frequently as children get older, and typically are more effective in the regulation of distress (Fox & Calkins, 2003; Grolnick et al., 1996; Kopp, 2002; Silk, Shaw, Skuban, Oland, & Kovacs, 2006). The involvement of attentional control, including sustained attention, in active emotion regulation strategies is facilitated by an overlap in the neural circuitry involved in both emotion regulation and sustained attention, particularly via the ACC and the orbitofrontal cortex (Beauregard, Levesque, & Paquette, 2004; Ernst et al., 1994; Rubia et al., 2008; Smith, Taylor, Brammer, Toone, & Rubia, 2006).

Given the neural circuitry overlap involved in both sustained attention and emotion regulation, it is reasonable to expect an association between both skills. Indeed, clinical research has shown that children with significant sustained attention deficits such as those diagnosed with ADHD are more likely to have co-occurring emotion regulation difficulties (Melnick & Hinshaw, 2000; Walcott & Landau, 2004). While the role of attention in facilitating active emotion regulation strategies has been well documented (Rothbart & Bates, 2006; Rueda *et al.*, 2005), it remains unclear within non-clinical samples whether toddlers' use of active versus more passive emotion regulation strategies relate to their level of sustained attention during non-emotional situations. Furthermore, measurement of sustained attention in studies that have also examined emotion regulation has relied primarily on parent questionnaires (Melnick & Hinshaw, 2000; Walcott & Landau, 2004). Having an observational measure of sustained attention during non-emotional situations is critical for understanding the extent to which attention based emotion regulation strategies can index toddlers' overall attentional abilities in a more cognitive setting.

The Present Study

The goal of the present study was to examine the role of maternal behaviour and children's emotion regulation strategies in the development of children's sustained attention abilities. A major limitation in the research on the role of maternal behaviour in children's cognitive development is that most studies have focused on general measures of cognitive function such as IQ. For example, maternal scaffolding and a generally positive and nurturing mother-infant interaction have been found to predict higher IQ scores (Andersson, Sommerfelt, Sonnander, & Ahlsten, 1996; Morelock, Brown, & Morrissey, 2003). Fewer studies have examined specific laboratory measures of attentional functioning. Global measures of maternal sensitivity have been found to be related to higher levels of joint attention (Findji, 1993; Landry & Chapieski, 1988; Raver & Leadbeater, 1995) as well as sustained attention (NICHD, 2005). Whereas these positive maternal behaviours have been associated with higher attentional functioning, negative maternal behaviours are also related to deficits in sustained attention. For example, children with AD/HD are more likely to have parents who display negative parental behaviour such as negative control strategies as well as not withdrawing control during collaboration tasks (Winsler, 1998). Similarly, high levels of maternal redirecting and intrusiveness have also been found to predict poorer infant focused attention and distractibility (Bono & Stifter, 2003; Jacobvitz & Sroufe, 1987). A recent experimental manipulation study also found that infants have longer durations of sustained attention when interacting with a sensitive individual as opposed to a more intrusive individual (Miller, Ables, King, & West, 2009).

Unfortunately, most of the studies that examined the link between maternal behaviour and sustained attention were either cross-sectional or only focused on the infancy or school age period. No longitudinal study to date has examined the role of maternal behaviour in the development of sustained attention during the toddlerhood to preschool period. The current study extended such research by examining the effects of positive maternal behaviour (warmth and responsiveness) and negative maternal behaviour (over-control/intrusiveness) on the development of children's sustained attention from toddlerhood through the preschool period. It was expected that early positive maternal behaviour

characterized by warmth and responsiveness would be positively related to the development of sustained attention while early negative maternal behaviour characterized by overcontrol/intrusiveness would be negatively related to the development of sustained attention.

Developmental research that has examined the link between emotion regulation and attentional functioning has mainly concentrated on how early attentional abilities facilitate the development of active emotion regulation strategies such as distraction (Belsky, Friedman, & Hsieh, 2001; Kopp, 2002; Rueda *et al.*, 2005) as well as effortful control abilities (Rothbart & Bates, 2006). No study to date, however, has examined whether toddlers' use of active versus more passive emotion regulation strategies relate to their level of sustained attention during non-emotional situations. Based on previous research, we hypothesized those more active emotion regulation strategies (e.g. distraction, initiation of help-seeking), which rely more heavily on attentional control, would be positively related to sustained attention in a non-emotional setting. On the other hand, more passive strategies, such as self-comforting and avoidance behaviours (e.g. trying to escape the frustrating situation), were expected to be negatively related to sustained attention in a non-emotional setting.

Finally, it is important to recognize the potential for interactions between children's emotion regulation strategies and maternal behaviours in their associations with children's sustained attention development. Although a detailed discussion is outside of the scope of the current paper, there is good evidence showing how maternal behaviours can buffer some of the negative effects of children's poor emotion regulation skills (see Calkins, 2007). Thus, the level of support in the mother-child interaction may influence the extent to which children can apply their attentional skills observed during an emotional situation to a more cognitively based situation.

METHOD

Participants

Participants for this study included 343 children (183 girls) obtained from three different cohorts participating in a larger ongoing longitudinal study. Four hundred and forty-seven participants were initially recruited at 2 years of age through child care centres, the County Health Department, and the local Women, Infants, and Children program. In order to obtain a broad, community-based sample of children with a wide range of disruptive behaviour, potential participants were screened using the externalizing subscale of the Child Behaviour Checklist (CBCL 2-3; Achenbach, 1992). The goal for recruitment was to obtain a sample of children who were at risk for developing future externalizing behaviour problems. Children were identified as being at risk for future externalizing behaviours if they received an externalizing T-score of 60 or above. Of the entire sample ($N = 447$; 215 males), 37% of the children were identified as being at risk for future externalizing problems. Further details about the recruitment may be found in Smith, Calkins, Keane, Anastopoulos, and Shelton (2004). The recruitment sample was diverse with sixty-seven percent of the children classified as European American, 27% as African American, 4% as biracial, and 2% as Hispanic. At age 2, the children were primarily from intact families (77%), and families were economically diverse, with Hollingshead (1975) scores ranging from 14 to 66 ($M = 39.56$). Of the original 447 participants, 399

participated at 4.5 years of age assessment. Owing to the multiple assessments sample sizes vary, with 343 children (183 male) having complete data. This sample of children was racially and economically diverse (66% European American; mean Hollingshead score = 39.6), and primarily from intact families (80%). In terms of educational background, 49% of the mothers in our sample had a college degree or higher, 35% had completed some college, 12% only had a high school degree, and 4% did not finish high school. There were no significant differences in any demographic variables between children with complete versus partial data.

Procedures

The focus of this study involved several laboratory assessments at the 2-year and 4.5-year visits. When the children were 2 years of age, mothers brought their children to the laboratory and were videotaped during several tasks. The order of the tasks was standardized and children were given small breaks at the end of each task to ensure that there were no carry over effects from one task to another. The first task was a sustained attention task in which children were instructed ('We're going to watch some TV now. This is a video about Spot the dog. I need you to sit and watch this quietly') to watch a 5-min segment of the videotape 'Spot', a short story about a puppy that explores its neighborhood. Following this task, children engaged in six mother-child interaction tasks to code observed maternal behaviour: four teaching tasks (4 min each) where the mother was instructed to assist the child during a challenging task (various puzzles), a freeplay procedure (4 min) in which the mother was instructed to play with her child as she would at home, a clean-up task (2 min) where the mother was to try and get the child to clean up the toys from the freeplay session. Once the mother-child interaction tasks were completed, children participated in two tasks designed to elicit emotion regulation. The prize in a box task, where a desirable toy was placed in a clear box that the child was unable to open for 2 min, and a high chair task, where the child was placed in a high chair without any toys or snacks for 5 min was used to code observed emotion regulation and emotional reactivity (LAB-TAB, Goldsmith & Rothbart, 1993). For the prize in the box task, the mother was asked to limit her interactions with her child, whereas during the high chair task she was instructed to respond to her child as she deemed was necessary. The tasks were ended early if the child was highly distressed or cried hard for more than 30 s.

While in the laboratory, mothers completed various questionnaires. A follow-up assessment took place when children were approximately 4.5 years of age. Similar to the 2-year visit, children's sustained attention during the 4.5-year visits was coded while they watched a 5-minute segment of the videotape 'Spot'.

Measures

Maternal behaviour

Maternal behaviour during six mother-child interactions at 2 years of age was coded according to global indices of *warmth/positive affect* (displaying positive affect and warmth toward the child), *sensitivity/responsiveness* (promptly and appropriately responding to the child's bids to her), and *overcontrol/intrusiveness* (exerting influence toward completion of the child's activity using directive methods; displaying a no-nonsense attitude; constantly guiding the child and

creating a structured environment). It is important to note that these maternal behaviours are globally coded while taking the child's behaviour and performance into account (e.g. two mothers can receive high global ratings for sensitivity/responsiveness even if one child provides more bids toward the mother than the other as long as both mothers responded with sensitivity/responsiveness when it was required). These global codes were adapted from the Early Parenting Coding System (Winslow, Shaw, Bruns, & Kiebler, 1995). Each behaviour was coded once for each episode on a 4-point scale (1 = low to 4 = high). Four coders trained on 10% of the videotaped sessions and independently coded another 10% for reliability. The adjusted Kappas for global codes were all above 0.70.

Emotion regulation

Prior research has shown relations between emotion regulation and emotion reactivity measures where reactivity is a part of the response to the contextual demands that require regulatory strategies to adjust for this change in reactivity (Calkins & Johnson, 1998). Thus, both degree of distress and specific regulatory behaviours are considered evidence of emotion regulation processes. Consequently, both emotional reactivity and specific emotion regulation strategies were coded from videotapes of the frustration tasks (Prize in the Box and High Chair). Four coders trained on 10% of the videotaped sessions and independently coded another 10% for reliability. Reliability Kappas across codings were all above 0.72. For reactivity, distress was defined as when the child whined, pouted, fussed, cried, screamed, or tantrummed. *Global negative reactivity* was coded on a scale from 0, meaning no negative response, to 4, meaning task ended with the child in extreme distress. We also coded for behaviours commonly considered indicators of emotion regulation. These regulation strategies were chosen based on previous research measuring regulation in young children (Calkins, 1997; Calkins & Dedmon, 2000; Stifter & Braungart, 1995). These emotion regulation strategies included: (a) *self-comforting*—thumb sucking, hair twirling, or other auto-manipulative behaviour; (b) *help-seeking*—looking to mom, talking to or playing with mother, touching or pulling on mom; (c) *distraction*—attending to or manipulating an object other than the task object; and (d) *avoidance*—child looking to escape situation. These emotion regulation strategies were also coded globally on a scale from 0, not used at all, to 3, often used throughout the task. These measures were used because they were thought to best index a child's level of reactivity and appropriate regulation skills especially during the Prize in the Box and High Chair tasks. The reactivity and regulation codes were averaged across tasks to produce a separate mean score for each. As seen in Table 2, while the observational measures of emotion regulation strategies and emotional reactivity were correlated, they do seem to be measuring distinct emotional processes. In addition, given our study's goal of examining the association between children's emotion regulation strategies and sustained attention, all analyses controlled for children's emotional reactivity.

Sustained Attention

Lab Measure. At 2 and 4.5 years of age, children were instructed to watch a 5-minute segment of the videotape 'Spot', a short story about a puppy exploring a neighborhood. During this task, the *overall duration*—referred to the proportion of time the child spent looking at the video—was coded and used as this study's

laboratory measure of sustained attention. The reliability among coders for the *overall duration* was excellent ($r = 0.98$ for the 2-year visit and $r = 0.96$ for the 4.5-year visit).

Data analytic Strategy

First, preliminary analyses (data reduction and descriptive statistics) were computed. Next, hierarchical regression analyses were conducted to examine the extent to which our predictor variables were associated with toddlers’ sustained attention at 2 years of age. Finally, regression analyses were conducted to examine whether maternal behaviours and toddlers’ emotion regulation strategies at age 2 could predict change in sustained attention from age 2 to 4.5.

RESULTS

Data Reduction and Preliminary Analyses

Sample sizes for all study measures are reported along with the descriptive statistics in Table 1. All analyses were conducted using SPSS 17. All available data were used for each analysis. Preliminary analyses focused on reducing the number of predictors and determining any associations between demographic characteristics and any of the study’s independent (i.e. maternal behaviour measures and children’s emotion regulation strategies) and dependent (i.e. sustained attention at 2 and 4.5 years) variables. First, the global codes for the maternal behaviours were averaged across the six mother–child interactions as their alphas were highly reliable (0.90 for warmth, 0.81 for overcontrol/intrusiveness, and 0.82 for responsiveness). Second, an examination of the relations between the maternal behaviour composites indicated that maternal

Table 1. Descriptive statistics for all variables

	M	S.D.	Min	Max	N
2-year measures					
Maternal education (P)	3.41	0.98	1	5	447
Maternal warmth (L)	3.07	0.75	1.17	4	428
Maternal responsiveness (L)	3.18	0.67	1.17	4	428
Maternal overcontrol/intrusiveness (L)	2.36	0.61	1	4	428
Emotional reactivity (L)	0.79	0.89	0	4	423
Emotion regulation: use of distraction (L)	1.34	0.34	.25	2.25	422
Emotion regulation: self-comforting (L)	0.77	0.38	0	1.75	422
Emotion regulation: avoidance (L)	0.48	0.47	0	2	422
Emotion regulation: help-seeking (L)	0.71	0.55	0	2.5	422
Sustained attention (L)	80.1	17.6	16.4	100	422
4.5-year measures					
Sustained attention (L)	91.4	9.07	41.0	100	357
Improvement in sustained attention (L)	11.7 ^a	16.98	−57.6	77.4	349

(P) = parent report, (L) = laboratory measure.
^aPositive score indicates an improvement in sustained attention from 2 to 4.5 years. Maternal Education was coded with 1 = some high school, 2 = high school degree, 3 = completed some college, 4 = college degree, and 5 = advanced graduate degree.

Table 2. Correlations among variables

Variable	1	2	3	4	5	6	7	8	9
1. Maternal W/R	—								
2. Maternal O/I	−0.14**	—							
3. Emotional reactivity	−0.06	−0.09	—						
4. ER: dis-traction	−0.02	−0.18***	−0.42***	—					
5. ER: self-comforting	0.23***	0.08	−0.32***	0.13*	—				
6. ER: avoidance	−0.04	0.07	0.45***	−0.20***	−0.15**	—			
7. ER: help-seeking	−0.19***	0.10	0.39***	−0.17**	−0.34***	0.27***	—		
8. SA-2year	0.11*	−0.30***	−0.21***	0.12*	0.04	−0.24***	−0.05	—	
9. SA-4.5 year	0.19***	−0.13*	−0.12*	0.01	0.07	−0.09+	−0.08	0.31***	—

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. All correlations controlled for maternal education and racial status. O/I = overcontrol/intrusiveness, W/R = warmth/responsiveness, ER = emotion regulation, SA = sustained attention.

warmth and responsiveness were high related ($r = 0.80, p < 0.001$) and thus were averaged into a single maternal warmth/responsiveness composite.

In terms of the demographic variables, correlational analyses indicated that maternal education was positively related to maternal warmth/responsiveness ($r = 0.35, p < 0.001$) and negatively related to maternal overcontrol/intrusiveness ($r = -0.26, p < 0.001$). Hence, this indicates that mothers with higher levels of education were more likely to interact with their children in a warm and responsive manner and less likely to interact with them in an intrusive manner compared to mothers with lower levels of education. Multivariate analyses indicated significant race differences across the maternal behaviour and sustained attention variables, $F(5, 334) = 20.33, p < 0.01$. Specifically, minority children had significantly lower sustained attention scores compared to Caucasian children at 2 and 4.5 years of age, $F(1, 338) = 24.76, p < 0.001$ and $F(1, 338) = 6.97, p < 0.001$, respectively. Minority children were also found to have mothers that interacted with them in a more overcontrolling/intrusive manner, $F(1, 338) = 37.44, p < 0.001$, and who displayed less warmth/responsiveness, $F(1, 338) = 57.55, p < 0.001$, compared to Caucasian children. Owing to these findings, maternal education and racial status were controlled in subsequent analyses. No other demographic characteristics were related to any of the study variables.

Associations between Maternal Behaviours, Emotion Regulation, and Sustained Attention at 2 years

Table 2 shows the correlations among the study variables after controlling for maternal education and racial status. Hierarchical regression analyses, controlling for maternal education, racial status, and emotional reactivity, were conducted to determine whether both maternal behaviours and toddlers’

emotion regulation skills were uniquely associated with sustained attention at 2 years of age. As seen in Table 3, even after controlling for maternal education, racial status, and emotional reactivity, toddlers' emotion regulation skills, specifically avoidance and help-seeking, were significantly related to sustained attention at 2 years of age. Specifically, high use of avoidance techniques was negatively associated with sustained attention while help-seeking behaviours were positively associated with sustained attention. Maternal behaviour characterized by high levels of overcontrolling/intrusiveness was also negatively related to sustained attention. No significant association emerged between maternal behaviour characterized by high levels of warmth/responsiveness and sustained attention nor were there any main effects for self-comforting or distraction. However, as seen in step 3, there were two significant interactions between maternal warmth/responsiveness and toddlers' use of self-comforting and distraction as emotion regulation strategies.

Following procedures outlined by Aiken and West (1991), these interactions were plotted by regressing sustained attention (*y*) on the emotion regulation strategies (*x*) as a function of two values of maternal warmth/responsiveness, *Z_L* and *Z_H* (i.e. one standard deviation below the mean, one standard deviation above the mean). Unstandardized *B* was used to calculate the regression lines. As depicted in Figure 1, children who had low use of distraction skills but who had mothers with higher levels of warmth/responsiveness generally had higher initial levels of sustained attention at age 2 compared to children with low use of distraction skills and who had mothers with lower levels of warmth/responsiveness. On the other hand, in the context of high use of distraction, no effect for maternal warmth/responsiveness on sustained attention was found. In Figure 2,

Table 3. Regression analyses testing the associations between maternal behaviors, emotion regulation strategies, and sustained attention at 2 years

	β	R^2	R^2 change	F change
Step 1		0.13	0.13	21.69***
Maternal education	0.10*			
Racial status	-0.17**			
Emotional reactivity	-0.11+			
Step 2		0.2	0.07	6.76***
Maternal O/I	-0.22***			
Maternal W/R	0.08			
ER: self-comforting	-0.04			
ER: distraction	0.01			
ER: avoidance	-0.18***			
ER: help-seeking	0.10*			
Step 3		0.25	0.05	3.19**
ER: self-comforting $\times$ Maternal O/I	-0.05			
ER: self-comforting $\times$ Maternal W/R	0.14**			
ER: distraction $\times$ Maternal O/I	-0.01			
ER: distraction $\times$ Maternal W/R	-0.09*			
ER: avoidance $\times$ Maternal O/I	-0.08			
ER: avoidance $\times$ Maternal W/R	0.08			
ER: help-seeking $\times$ Maternal O/I	-0.01			
ER: help-seeking $\times$ Maternal W/R	0.03			

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. *N* = 413. O/I = overcontrol/intrusiveness, W/R = warmth/responsiveness, ER = emotion regulation. Racial Status was dummy coded with 0 = Caucasian and 1 = Minority.

the opposite situation occurred in which maternal warmth/responsiveness had no effect on sustained attention in the context of low use of self-comforting emotion regulation skills. However, high levels of maternal warmth/responsiveness did buffer the negative association between high use of self-comforting emotion regulation skills and sustained attention. Finally, *t*-tests were computed, using Hayes and Matthes' (2009) macro, to determine whether the slopes of the lines plotted in Figures 1 and 2 were significantly different from zero. The

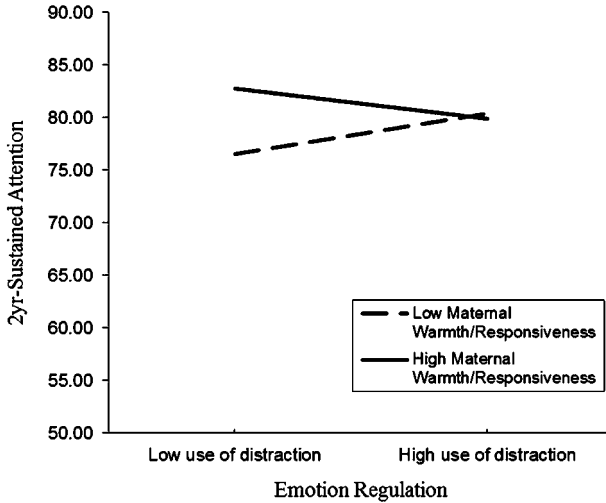


Figure 1. The interaction between toddlers' use of distraction as an emotion regulation strategy and maternal warmth/responsiveness as it predicts toddlers' sustained attention at 2 years of age.

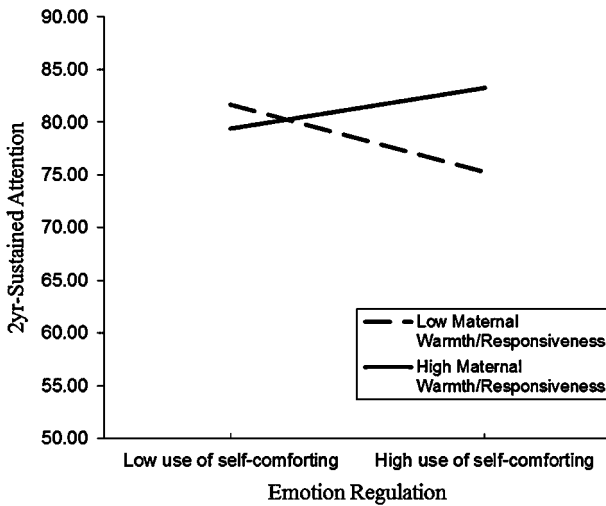


Figure 2. The interaction between toddlers' use of self-comforting as an emotion regulation strategy and maternal warmth/responsiveness as it predicts toddlers' sustained attention at 2 years of age.

resulting t tests indicated that for Figure 1, the slope for low maternal warmth/responsiveness was significantly different from zero, $t(414) = 2.71$, $p < 0.01$, $b = 3.26$ but the slope for high maternal warmth/responsiveness was not significantly different from zero, $t(414) = -0.73$, $p > 0.05$, $b = -0.91$. Similarly for Figure 2, the slope for low maternal warmth/responsiveness was significantly different from zero, $t(414) = -2.51$, $p < 0.05$, $b = -3.33$ but the slope for high maternal warmth/responsiveness was not significantly different from zero, $t(414) = 0.30$, $p > 0.05$, $b = 0.35$.

Predicting Sustained Attention Growth from 2 to 4.5 years of age

As seen by the change scores provided in Table 1, it is important to note that toddlers' sustained attention scores improved from age 2 to 4.5. In fact, only 23% of the sample did not improve their sustained attention scores from age 2 to 4.5. Hence, hierarchical regression analyses were conducted to determine whether maternal behaviours and toddlers' emotion regulation strategies at age 2 could predict change in sustained attention from age 2 to 4.5. The control variables (i.e. maternal education, racial status, and emotional reactivity) along with toddlers' 2-year sustained attention scores were entered in the first step of the regression. The main effects of maternal behaviours and toddlers' emotion regulation strategies were then entered into the second step of the regression followed by the interaction terms. The dependent variable for the regression analysis was 4.5-year sustained attention scores. As seen in Table 4, 2-year sustained attention was a significant predictor of 4.5-year sustained attention. Hence, children who displayed higher levels of sustained attention at 2 years of age were more likely to display higher levels of sustained attention at 4.5 years of age. After controlling for this baseline level of sustained attention, only the main effect of maternal warmth/responsiveness was a significant predictor of 4.5-year sustained attention. This indicates that children whose mothers interacted with them in a highly warmth/responsiveness manner were more likely to display improvements in sustained attention from 2 to 4.5 years of age compared to children whose mothers displayed low levels of warmth/responsiveness during interactions. Of note, no significant interactions emerged between the predictor variables.

DISCUSSION

This study was designed to address several gaps in the literature to assess how maternal behaviours and toddlers' various emotion regulation strategies relate to sustained attention during a non-emotional task. First and consistent with this study's hypotheses, toddlers who used high levels of avoidance regulatory behaviours displayed lower initial levels of sustained attention as measured in the laboratory at 2 years of age, while the use of help-seeking regulatory behaviours was positively associated with sustained attention. The use of distraction and self-comforting strategies were not on their own related to sustained attention, although interactions with maternal behaviour were found. These findings support past research identifying an important distinction between active versus more passive emotion regulation strategies and their implications for children's behavioural and social functioning, (Calkins & Dedmon, 2000; Grolnick *et al.*, 1996; Silk *et al.*, 2006). Our study extends the

Table 4. Regression analyses examining maternal behaviors and toddlers' emotion regulation strategies as predictors of sustained attention growth from 2 to 4.5 years of age

	β	R^2	R^2 change	F change
Step 1		0.13	0.13	12.69***
2-year-sustained attention	0.28***			
Maternal education	0.04			
Racial status	-0.01			
Emotional reactivity	-0.07			
Step 2		0.15	0.02	1.35
Maternal O/I	-0.03			
Maternal W/R	0.13*			
ER: self-comforting	0.01			
ER: distraction	-0.07			
ER: avoidance	0.01			
ER: help-seeking	-0.03			
Step 3		0.17	0.02	0.69
ER: self-comforting $\times$ Maternal O/I	0.03			
ER: self-comforting $\times$ Maternal W/R	0.03			
ER: distraction $\times$ Maternal O/I	0.02			
ER: distraction $\times$ Maternal W/R	0.02			
ER: avoidance $\times$ Maternal O/I	-0.01			
ER: avoidance $\times$ Maternal W/R	0.07			
ER: help-seeking $\times$ Maternal O/I	0.03			
ER: help-seeking $\times$ Maternal W/R	0.09			

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. $N = 342$. O/I = overcontrol/intrusiveness, W/R = warmth/responsiveness, ER = emotion regulation. Racial Status was dummy coded with 0 = Caucasian and 1 = Minority.

research literature by being the first to document the differential concurrent associations between active and passive regulatory behaviours and sustained attention.

It is important to note that counter to our expectations, toddlers' emotion regulation strategies did not predict improvements in sustained attention across time. This finding may be partially attributable to the fact that by 4.5 years of age most preschoolers were able to attend to the laboratory task thus reducing the variability in their scores. Additionally, future research might reveal that the reversal temporal sequence is in fact more important, such that sustained attention predicts changes in emotion regulation strategies. Thus, although the current study did not find evidence that certain emotion regulation strategies increase the developmental trajectory of sustained attention, higher levels of active emotion regulation strategies (e.g. help-seeking) and lower levels of passive emotion regulation strategies (e.g. avoidance behaviours), do appear to concurrently relate to children's sustained attention abilities in a non-emotional setting. This association is consistent with significant research showing an overlap in the neural circuitry involved in both emotion regulation and sustained attention, particularly via the ACC and the orbitofrontal cortex (Beauregard *et al.*, 2004; Ernst *et al.*, 1994; Rubia *et al.*, 2008; Smith *et al.*, 2006). The current study's findings provide some evidence that children who use more active emotion regulation strategies, which rely more heavily on attentional control, and less passive strategies are also able to implement such attention during non-emotional and more cognitive situations.

Second, as hypothesized, negative maternal behaviour characterized by overcontrol/intrusiveness was negatively associated with the initial status of sustained attention at 2-years of age as measured in the lab. It may be that maternal overcontrol/intrusiveness is a significantly negative and stressful environmental experience for the child to cause it to disrupt the child's ability to create his or her own environment (i.e. mature). The disruption of the child's creation of his or her own environment by a mother who is consistently nagging her child or interfering with her child's independence may interfere with various cognitive functions. Previous research in the temperament literature has found that maternal overcontrol/intrusiveness contributes to children's internalizing and externalizing behaviours (Campbell, 2002; Degnan, Almas, & Fox, 2010; Kochanska, 1997). The current study expands the literature by finding evidence that maternal overcontrol/intrusiveness is negatively associated with toddlers' sustained attention abilities. While we found no evidence that such maternal overcontrol/intrusiveness behaviour predicts slower growth in toddlers' sustained attention development, we did find that maternal warmth/responsiveness behaviour positively predicts faster growth in toddlers' sustained attention abilities. Previous research on the benefits of positive maternal behaviour had focused on planning abilities, general cognitive measures, or joint attention in infancy. The current study's findings extend previous research and indicate that toddlers who have mothers who interact with them in a positive and responsive manner, even in non-teaching situations, tend to show higher levels of sustained attention growth from ages 2 to 4.5.

Significant maternal behaviour-child emotion regulation strategies interactions emerged such that high levels of maternal warmth/responsiveness buffered the negative association between low use of distraction and high use of self-comforting emotion regulation strategies and sustained attention at age 2. While there is significant research showing how maternal behaviours can buffer some of the negative effects of children's poor emotion regulation skills (see Calkins, 2007), the study of such interactions has mainly focused on predicting externalizing problems (see van Aken, Junger, Verhoeven, van Aken, & Dekovic, 2007 for a review), moral behaviour (Kochanska, 1997), and subsequent emotion regulation (Calkins, 2007; Dennis, 2006). Our findings extend previous work by providing tentative evidence for how warm and responsive parental behaviour can buffer some of the negative associations of more passive or less active emotion regulation strategies (e.g. high self-comforting, low distraction) with a crucial attentional capability (i.e. sustained attention).

In terms of this study's limitations, several methodological issues need to be acknowledged. First, the lab measure of sustained attention became easier as children got older limiting the variability of scores at the 4.5-year visit. Because our measure of sustained attention was obtained via a video task, it also remains unclear whether toddlers' previous television watching experience could impact their performance during our task. It would be important for future research to attempt to use more novel standardized tasks. One challenge in conducting attention research with young children is that standardized attention tasks such as the Conners Continuous Performance Task are unavailable during toddlerhood which makes it difficult to examine its growth across time, which often necessitates the same tasks across time (Anastopoulos & Shelton, 2001; Corkum & Siegel, 1993). The fact that the current study was able to find various initial effects using simply an attention to video task is encouraging. Nevertheless, it will be important for future studies to validate the use of an attention to video task while controlling for children's previous video watching experience. Second,

it is important to point out that we were not able to control for the potential effects of genetics and overall intelligence on children's sustained attention development, although our findings remained even after accounting for maternal education. Third, the predictors (emotion regulation and maternal behaviours) were assessed only at the initial time point. As emotion regulation strategies are also changing during this developmental period, a model that takes into account such dynamic changes by having multiple measures of emotion regulation across time would provide answers to other potentially interesting questions. For example, do changes in children's use of active emotion regulation strategies occur in parallel with changes in sustained attention in non-emotional settings? Lastly, another related limitation is the inability to determine the directionality of their associations. Thus, although the maternal behaviours and emotion regulation strategies were measured at an early point in life, it is plausible to argue that they are a reaction to or consequence of children's earlier attentional abilities. Future studies may be able to address the directionality of their associations by examining whether changes in the trajectories of maternal behaviour or emotion regulation strategies over time directly map onto changes in sustained attention.

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