# A DEVELOPMENTAL MODEL OF EFFORTFUL CONTROL: THE ROLE OF NEGATIVE EMOTIONALITY AND REACTIVITY, SUSTAINED ATTENTION IN MOTHER-CHILD INTERACTION, AND MATERNAL SENSITIVITY

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#### **ABSTRACT**

Min Deng: A Developmental Model of Effortful Control: The Role of Negative Emotionality and Reactivity, Sustained Attention in Mother-Child Interaction, and Maternal Sensitivity

(Under the direction of Jean-Louis Gariépy)

The present research examined how early temperamental predispositions, caregiving environment, and the interactions among these factors shape the developmental pathways to effortful control in early childhood. The developmental model of effortful control in this research involved two child factors, negativity and sustained attention, an environmental factor indexed by maternal sensitive behaviors, and the interaction effects among these variables. Both variable-oriented and person-oriented analyses were conducted to test the propositions of this model. The findings suggested that the distress to limitation scale of the IBQ-R and high distress in the arms restraint procedure at 6 months of child age had opposite effects on effortful control at 36 months. Mother-reported ratings on the distress to limitation scale were negatively associated with effortful control, while the percentage of time during which the child was observed in high levels of distress in lab was found to be positively related to effortful control under many conditions, when significant three-way interaction effects were probed. Secondly, there was general support for the notion that the relations between negative emotionality and reactivity were moderated through two pathways, the child's capacity to regulate attentional processes and maternal sensitivity, respectively. The findings involving sustained attention obtained in a social context highlighted the importance of employing

multiple measures obtained in varying contexts to assess the same construct. Thirdly, consistent with extant literature, the protective effect of maternal sensitivity on effortful control was stronger for children who were perceived by their mother as more prone to distress. Interestingly, both child sex and maternal education emerged as important moderators in interaction effects. However, no support was found for the hypothesis that the pathways to effortful control may be best understood as a joint function of child negativity, child sustained attention and maternal sensitivity. Lastly, two group profiles revealed by latent class analyses fit nicely with the interaction effects from regression models. The findings highlight the processes of amplification or attenuation that operate in development by which children with similar beginnings end up taking different trajectories.

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#### I. INTRODUCTION

The construct of effortful control has been of particular interest to developmental psychologists in the past two decades. Mary Rothbart first introduced it to describe a level of volitional control that emerges in children's development (Rothbart, 1989). She defined effortful control as "the ability to inhibit a dominant response to perform a subdominant response, to detect errors, and to engage in planning" (Rothbart & Rueda, 2005, p. 169). In her model of temperament, effortful control is conceptualized as a major form of self-regulation (Ahadi & Rothbart, 1994; Rothbart, Ahadi, Hershey, & Fisher, 2001; Rothbart & Rueda, 2005). A substantial body of research has shown that effortful control plays an important role in the development of a wide range of socioemotional outcomes, including compliance (Kochanska, Coy, & Murray, 2001; Kochanska, Tjebkes, & Forman, 1998), moral conscience (Kochanska, Murray, & Coy, 1997; Rothbart, Ahadi, & Hershey, 1994), empathy/sympathy (Eisenberg, Fabes, Murphy, Karbon, Smith, & Maszk, 1996; Murphy, Eisenberg, Fabes, Shepard, & Guthrie, 1999), prosocial behavior (Eisenberg, Fabes, Karbon, Murphy, Wosinski, Polazzi, Carlo, & Juhnke, 1996; Eisenberg, Guthrie, Fabes, Resier, Murphy, Holmgren, Maszk, & Losoya, 1997), and social competence and adjustment (Caspi, 2000; Henry, Caspi, Moffitt, Harrington, & Silva, 1999; Lemery, Essex, & Snider, 2002).

Rothbart proposed that effortful control emerges late in the first year, and undergoes considerable development between two and seven years of age (Rothbart & Bates, 2006; Rothbart & Rueda, 2005). This is supported by research showing that around three years

of age, performances on laboratory batteries designed to measure effortful control become fairly stable and highly consistent across tasks (Kochanska, Murray & Harlan, 2000; Murray & Kochanska, 2002). Because effortful control is a later-developing dimension of temperament that is implicated in a broad range of developmental outcomes, it is critical to identify the developmental pathways leading to its functional organization in the young child.

In Rothbart's model of temperament, reactivity is clearly distinguished from self-regulation. Individual differences in reactions to external stimuli are readily observable and measurable in newborns, while self-regulatory systems do not develop until later in infancy. With the development of self-regulatory systems, children begin to control their reactivity in ways that promote a better adjustment to the demands of their environment. However, Rothbart observes that all children are not equal in this regard and that the efficiency of these regulatory systems depends upon the strength of the reactivity against which regulatory control is exerted (Rothbart & Bates, 2006; Rothbart & Rueda, 2005). Reactivity to stimuli takes two forms — positive and negative, with negative reactivity presenting a particular challenge in the development of self-regulation (Rothbart & Bates, 2006). For this reason, Rothbart and Sheese (2007) maintain that it is essential to examine the development of regulatory capacities against the background of infantile reactivity.

The organization of the attentional network over the first two years of life is of particular importance to the developmental acquisition of control over reactive responses (Posner & Rothbart, 2000). Attentional orienting, although reflexive early in life, was shown to decrease reactivity in young infants. For example, Harman, Rothbart, and Posner (1997) showed that when three- and six-month-old infants in distress were

presented with distractors, attentional orienting had regulative effects on the expression of their distress. Strong and extended attentional orienting is also considered essential to the development of inhibitory control during the second half of the first year (Rothbart, 1988). Research suggests that the emergence of sustained or focused attention at six months reflects the organization of the posterior orienting network which becomes fully functional around that age (Ruff & Rothbart, 1996). Toward the end of the first year, with the maturation of the frontal cortex, sustained attention starts to reflect the operation of the executive attention network. At this point, the child uses attentional processes to plan and monitor the course of goal-oriented actions. In this function, sustained attention also becomes self-regulatory. Further development of the executive attention network over the next several years provides the necessary substrate for the volitional (i.e., effortful) control of action and emotional responding (Rothbart & Bates, 2006; Rothbart, Ellis, Rueda, & Posner, 2003; Rothbart & Rueda, 2005). It is thus reasonable to infer that the variations in sustained attention observed toward the end of the first year reflect biological differences that may influence later developing capacities for effortful control. In this regard it is worth noting that few studies have examined the association of sustained attention with the development of effortful control against the background of early negative emotionality.

Although effortful control is believed to have a strong constitutional basis, its development is also very likely influenced by experience, and by parenting practices in particular (Rothbart & Bates, 2006). The evidence in this regard points to sensitive parenting as a key factor (Kochanska et al., 2000; Lengua, Honorado, & Bush, 2007; Olson, Bates, Sandy, & Schilling, 2002). On the other hand, there is a large range of child

outcomes that are now known to be determined by interactions between child and parental factors (Belsky, 1997a, 1997b; Feldman, Greenbaum, & Yirmiya, 1999; Gilliom, Shaw, Beck, Schonberg, and Lukon, 2002; Hemphill & Sanson, 2001; Kochanska, 1997). For example, it is well established that child negativity exacerbates the effects of negative parenting on the emergence and consolidation of externalizing problems in childhood (e.g., Belsky, Hsieh, & Crnic, 1998; Morris, Silk, Steinberg, Sessa, Avenevoli, & Essex, 2002). While moderating effects of this nature have been identified as critical factors in the development of pathological problems, their role in the development of adaptive outcomes like effortful control remains to be fully investigated. For instance, there have been relatively few studies conducted with the explicit goal of examining how sensitive parenting behaviors and child negativity may jointly predict the development of effortful control in early childhood.

This broad review suggests a general model of the development of effortful control that specifies two child factors, emotional reactivity and sustained attention, an environmental factor primarily indexed by sensitive parental behaviors, and the interaction effects among these variables over time. In its simplest aspect, this model predicts a negative relation between six-month child negativity and 36-month effortful control. Next, it stipulates two pathways that may moderate this relation, the child's capacity to regulate attentional processes and maternal sensitivity, respectively. This model further specifies that the pathways to effortful control may be best understood as a joint function of child negativity, child sustained attention, and maternal sensitivity. The goal of the present study was to empirically test these propositions.

#### 1.1 Negative Emotionality and Reactivity

Temperament broadly defined refers to individual differences in reactivity and selfregulation that are assumed to have a constitutional basis (Rothbart & Bates, 2006; Rothbart & Derryberry, 1981). The term constitutional refers to the relatively enduring biological makeup of the organism, influenced over time by heredity, maturation and experience. Reactivity refers to the behavioral and physiological responsiveness of the organism to changes in its external and internal environments. It includes a wide range of reactions, such as motor, affective, attentional, and physiological reactions (Rothbart & Derryberry, 1981). There are two forms of reactivity — positive and negative that can be observed in the neonate. Negative emotionality consists of a propensity to show various forms of negative affect such as generalized distress, frustration/anger, and fear. The second aspect of temperament, self-regulation, refers to neural and behavioral processes (e.g., effortful control) that serve to modulate the underlying reactivity (Rothbart & Bates, 2006; Rothbart & Derryberry, 1981). Effortful control is conceptualized as a major form of self-regulation that emerges late in the first year and continues to develop through childhood.

The distinction between reactivity and self-regulation is of particular importance in Rothbart's conception of temperament. When infants come to the world, much of their behavior reflects how reactive they are to external stimuli and their own internal states. With the organization of the first regulatory systems (e.g., inhibited approach), the child begins to regulate negative emotions by controlling her approach to pleasant stimuli or avoidance of fearful situations. With more advanced forms of self-regulation, like effortful control, the child becomes capable of voluntarily inhibiting dominant actions

and initiating more appropriate ones as she monitors her progress toward an achievable goal. How efficient effortful control is in these circumstances depends on the strength of the emotional reactivity against which effort is exerted (Rothbart & Bates, 2006).

Thus, it is not surprising that studies of temperament regularly find concurrent inverse relationships between negative affectivity and effortful control (Rothbart et al., 2003). Using dimensions of the Children's Behavior Questionnaire (CBQ, Rothbart et al., 2001) identified by factor analysis, Ahadi and colleagues (1993) reported that effortful control measures were inversely related to negative emotionality in U.S. child and adult samples. Kochanska and colleagues (2000) also found that children who performed better on a battery of effortful control tasks in the laboratory showed more regulated anger at the same ages (22 and 33 months) during frustration tasks. Other studies have indirectly demonstrated a concurrent inverse relationship between negative emotionality and effortful control in early childhood. For example, Gerardi-Caulton (2000) found that 30and 36-month-olds who received higher parental ratings of anger and frustration on the CBQ performed worse on a measure of executive attention (i.e., a spatial conflict, Strooplike task) believed to underlie effortful control (Rothbart & Rueda, 2005; Rothbart et al., 2003). Similarly, in a sample of four- to six-year-olds, Eisenberg and colleagues (1993) showed that teachers' reports of attentional control were negatively related to their ratings of negative emotionality.

Although effortful control is considered a major form of self-regulation, there has been surprisingly limited research that examined the impact of infantile negative emotionality on its development. To my knowledge, there exist only two longitudinal studies that did so. One of these, reported by Kochanska and Knaack (2003), found that

toddlers prone to display anger at 14 and 22 months of age scored lower on multiple tasks of effortful control at 22, 33, and 45 months of age. It is important to emphasize that this study, not only revealed concurrent inverse relations between the intensity of anger and effortful control, but also a longitudinal relationship between early proneness to anger and later capacities for effortful control. Based on this research, Li-Grining (2007) tested the hypothesis that similar relations over the same age range could be found using a sample of low-income, predominantly African American and Latino children. Unexpectedly, her research revealed no significant longitudinal relations between children's proneness to negative emotionality and individual differences in effortful control. The author noted that the discrepancy between her findings and those of Kochanska and Knaack (2003) could be attributed to differences in measurement of negative emotionality. Kochanska and Knaack (2003) used both observational tasks and standardized temperament reports to assess negative emotionality, while Li-Grining (2007) used a simple three-item scale ("child gets upset easily," "child tends to cry easily," and "child has a quick temper") as a rough proxy of the same construct.

Albeit limited, the evidence available to date suggests that infantile negative emotionality impacts negatively the development of effortful control. This is also consistent with the view that a propensity toward negative emotionality is a risk factor in development, and that the acquisition of a capacity to modulate negative affect is a necessary condition for the development of self-regulation (Kopp, 1989; Lawson & Ruff, 2004; McCabe, Cunnington, & Brooks-Gunn, 2004; Rothbart & Bates, 2006). Clearly, infants need to experience and communicate negative emotionality to learn that certain strategies are regulatory. On the other hand, high levels of distress may hinder the

recruitment of effective regulatory behaviors and may also limit the opportunities for parents to promote appropriate strategies or support existing ones (Kopp, 1989; Stifter & Braungart, 1995; Stifter, Spinrad, & Braungart-Rieker, 1999). Evidence suggests that a difficult temperament as early as three months of age may compromise the development of self-control in toddlerhood (Feldman et al., 1999). Stifter and Spinrad (2002) found that boys who cried excessively in daily life at six weeks of age demonstrated lower levels of self-regulation later in the first year. Similarly, in a study of child compliance, Stifter and colleagues (1999) reported that highly reactive infants who also demonstrated low levels of regulatory behaviors were more likely to become noncompliant as toddlers. The same association is also evident in other longitudinal studies. For instance, Pettit and Bates (1989) found that a difficult temperament at age two predicted behavior problems at age four. In addition, Rodriguez and colleagues (2005) demonstrated that toddlers' negative affect, particularly in a high stress situation, predicted children's later use of ineffective attentional control strategies in a delay of gratification paradigm at age five.

One goal of the present study was to examine the longitudinal linkage between infantile negative emotionality and effortful control at 36 months of age. Note that fearfulness, although conceptualized by Rothbart as an aspect of negative reactivity, was excluded in the present study. This decision was based on evidence showing that infantile fear has often been associated with positive child outcomes (e.g., Karrass & Braungart-Rieker, 2004). In particular, Kochanska & Knaack (2003) showed that fearful infants tend to score higher on measures of effortful control in early childhood. By contrast, negative emotionality indexed by generalized distress, frustration, and anger has been shown to interfere with the acquisition of regulatory capacities and predict poor social

adjustment later in childhood. It was thus exclusively this latter form of negative emotionality, referred to as "distress to limitation" in the temperament literature that was considered in the present study. Under this restricted definition it was hypothesized that infants high in negative emotionality may have more difficulty than their more placid peers to acquire a capacity for effortful control in early childhood. Both objective measures obtained in the laboratory and standardized temperament questionnaires were used to assess infant negativity at six months and effortful control at 36 months.

#### 1.2 Sustained Attention

While negative emotionality may constrain the development of effortful control, the extent of this effect may depend upon the strength of the inhibitory controls that eventually become available to the infant via the regulation of attentional processes (Rothbart, 1988). Just like reactivity, attentional regulation is believed to have a constitutional basis. It is also posited to underlie the development of more advanced forms of regulation. Thus, the child's ability to sustain, focus and/or redirect attention by the end of the first year may be an important moderator of the relationship between initial negativity and later effortful control capacities.

Three distinct attention networks that relate to different aspects of attention have been identified in neurobiological and brain imaging studies (Bush, Luu, & Posner, 2000; Corbetta, 1998; Fan, McCandliss, Fossella, Flombaum, & Posner, 2005; Fan, McCandliss, Sommer, Raz, & Posner, 2002; Posner & Petersen, 1990; Rothbart & Bates, 2006). These three networks carry out the functions of alerting, orienting, and executive attention (Posner & Fan, 2007; Posner & Rothbart, 2007), among which orienting and executive attention are of particular interest to the present investigation. Orienting refers to the

alignment of attention to signals or stimuli by focusing, disengaging, or shifting attention (Rothbart & Bates, 2006). Orienting may occur overtly when it is accompanied by eye movements, or may be covert without any eye movement. This first aspect of attentional behavior has been associated with neural networks that include the superior parietal lobe, the temporal parietal junction, the superior colliculus, and the frontal eye fields (Corbetta & Shulman, 2002; Posner & Fan, 2007; Posner & Raichle, 1996; Posner & Rothbart 2007). Research has shown that the capacity to consistently focus, disengage, shift and refocus attention in response to external stimuli is present by six to nine months of age in most individuals (Colombo, 2001). Through most of the first twelve months of life, sustained attention reflects the operation of the orienting network. Toward the end of the first year, with modest development in the anterior attentional system, sustained attention starts to reflect the operation of the executive attention network. This is also when early signs of executive attention begin to emerge, which include increased attentional control, duration of orienting, and sustained or focused attention (Posner & Rothbart, 2000; Rothbart & Bates, 2006; Ruff & Rothbart, 1996).

The executive attention network is posited to underlie the development of effortful control (Posner & Rothbart, 2000; Rothbart & Bates, 2006). It is involved in the enactment of goal-directed behaviors, such as planning actions, monitoring and resolving conflict, selecting among competing demands, initiating and maintaining purposeful behavior, as well as interrupting or modifying behavior (Posner & Rothbart, 2007; Rothbart & Rueda, 2005). The neural network that supports executive attention comprises the anterior cingulate cortex and the lateral prefrontal cortex (Fan et al., 2005; Posner & Rothbart, 2007; Rothbart & Sheese, 2007). Rothbart and colleagues postulated

that the maturation of the executive attention network underlies the development of effortful control (Rothbart & Bates, 2006; Rothbart et al., 2003; Rothbart & Rueda, 2005). Imaging studies have provided support for this proposition by showing a correspondence between performance on effortful control tasks and activation of the executive attention network (Rothbart & Rueda, 2005). In a sample of preschoolers attending a Head Start program, Chang and Burns (2005) found that parental ratings of effortful control were positively associated with children's performance on executive attention tasks. In a similar study, Gerardi-Caulton (2000) reported that 30- and 36-month-old children who received higher parental ratings of effortful control showed better performance on a spatial conflict task (a measure of executive attention).

The above review suggests that variations in sustained or focused attention measured toward the end of the first year should be related to individual differences in effortful control observed in early childhood. This is indeed what Krakow and colleagues (1981) and Kochanska et al. (2000) reported. Both found sustained/focused attention measured either at nine or twelve months to predict greater effortful control in early childhood. More generally, consistent variations in attention early in life appear to contribute to individual differences in regulatory capacities later in development. This generalization is supported by research conducted over the last thirty years in the related domain of self-regulation (e.g., Kopp, 1982; Mischel & Ebbesen, 1970; Shoda, Mischel, & Peake, 1990). An example of this type of research is a study by Kochanska, Tjebkes, and Forman (1998) who reported that children who were able to focus attention for long durations at 8-10 months of age scored higher on measures of committed compliance (an aspect of self-control) at 13-15 months of age.

Regarding more specifically the relation between negative emotionality and sustained/focused attention, recent research suggests that attentional focus reduces distress in infancy (Rothbart & Sheese, 2007). In this respect, Calkins and colleagues (2002) reported that easily frustrated six-month-olds exhibited less focused attention during an attention task, and were described as less attentive by their parents, compared to less easily frustrated infants. Similarly, Kochanska, Coy, Tjebkes, and Husarek (1998) found that eight- to ten-month-old infants who were capable of sustaining attention to toys for longer durations during play were better modulators of their negative emotionality in a variety of aversive laboratory contexts. Finally, Matheny and colleagues noted that high focused attention was not only associated with better modulation of negative affect but also with more smiling and pleasure at 9, 12 and 24 months (Matheny, Riese, & Wilson 1985; Matheny, Wilson, & Nuss, 1984; Wilson & Matheny, 1983). Thus, taken together, extant research suggests that attentional focusing is linked to a better capacity to modulate negative emotionality in the first years of life.

There is also evidence that negative emotionality and attention interact with one another in the development of social competence or self-regulation. Belsky, Friedman, and Hsieh (2001) reported that high levels of negative emotionality at 15 months were associated with low levels of social competence at 30 months only when attentional persistence was poor. Using a global measure of behavior problems as the outcome, Lawson and Ruff (2004) showed that children with high levels of negative emotionality and low levels of observed attentiveness were more likely to develop behavior problems in early childhood, compared to children with only one or none of the risk factors. Additionally, Eisenberg and colleagues reported that negative emotionality and attention

moderate each other's effects in the prediction of social competence among preschoolers and school-age children (e.g., Eisenberg et al., 1993; Eisenberg, Fabes, Murphy, Maszk, Smith, & Karbon, 1995; Eisenberg, Fabes, Shepard, Murphy, Guthrie, Jones, Friedman, Poulin, & Maszk, 1997). Together, these studies suggest that attention may be an important factor in the modulation of negative emotionality, and that good attention skills may attenuate its effects on developmental outcomes.

Although several studies have suggested that negative emotionality and attention may interact with one another in the development of regulatory capacities, there is limited research that examined how their interaction may affect the development of effortful control. At this juncture, I planned to test the hypothesis that sustained attention was a positive contributor to the development of effortful control. High levels of sustained attention were also expected to attenuate significantly the adverse effect of negative emotionality on the development of effortful control, such that children prone to distress may acquire levels of effortful control comparable to those of their more placid peers if they show a capacity for attentional control (with sustained attention as a proxy) around twelve months of age. Conversely, I expected that the combination of high negative emotionality and low sustained attention to be more detrimental to the development of effortful control than the presence of only one or none of these factors.

#### 1.3 Maternal Sensitivity

The developmental model proposed so far stipulates that the acquisition of effortful control by three years of age is influenced by two child factors, child negativity at six months of age and sustained attention at twelve months, and by their interaction over time. This model would not be complete without giving consideration to environmental

factors. In this regard, Rothbart proposed that in spite of a relatively strong hereditary basis, the development of effortful control, like other temperamental characteristics, remains open to experience in the social world, and to interactions with parents in particular (Eisenberg, Smith, Sadovsky, & Spinrad, 2004; Rothbart & Bates, 2006). Multiple studies have provided support for the view that warm, supportive, and sensitive parenting fosters the development of effortful control in childhood. For example, Kochanska and colleagues (2000) found that maternal responsiveness to children at 22 months of age (such as promptness, engagement, sensitivity, acceptance, cooperation, availability, etc.) predicted better effortful control at both 22 and 33 months. In a sixmonth longitudinal study, Lengua and colleagues (2007) reported that maternal scaffolding predicted a significant improvement in effortful control in preschoolers. Furthermore, Olson and colleagues (2002) reported that six-month-old infants who received higher levels of maternal cognitive stimulation during mother-child interactions scored higher on an inhibitory control scale by eight years of age compared to other children who were less stimulated in this manner. In this study the authors also showed that low levels of maternal restrictiveness had the same effect.

More broadly, positive and/or sensitive parenting has been postulated to promote the development of self-regulation in young children (Kopp, 1982, 1987). During regular parent-child interactions, a sensitive parent helps regulate the child's emotional states by consistently observing and responding to the child's social gestures, emotional expressions and signals, providing appropriate stimulation, and modulating the child's arousal levels. The quality of the external regulation provided by the parent is an important precursor of the child's acquisition of self-regulative capacities (Cole, Martin,

& Dennis, 2004; Spangler & Grossman, 1993; Sroufe, 1996; Tronick, 1989). This facilitative role of sensitive parenting in the development of self-regulation was demonstrated by Lehman and colleagues (2002) and by Feldman and Klein (2003) among others who found in independent studies that sensitive parenting was associated with toddler's self-regulated compliance to the parents. Toddlers were also observed to use constructive coping strategies in challenging or frustrating situations when their parents provided positive guidance (e.g., praise, physical affection, and encouragement; Calkins and Johnson, 1998). A similar finding was reported by Gilliom and colleagues (2002) who showed that 42-month-old low-income boys raised by warm and supportive mothers were more likely to shift attention from a source of frustration.

In the context of an earlier body of research on infant-mother attachment it has been shown that sensitivity is not an attribute that caregivers possess in fixed quantities but a relational quality influenced by the characteristics that both mothers and infants bring to their interactions. Research with irritable infants, in particular, has shown that child temperament can affect maternal sensitivity in important ways (e.g., Crockenberg, 1981; Goldsmith and Alansky, 1987; van den Boom, 1994). Recent research on the effects of parenting on child self-regulation similarly finds that child characteristics need to be taken into account. A number of studies have reported that child temperament and parenting practices made independent and additive contributions to developmental outcomes (e.g., Calkins & Johnson, 1998; Sanson, Obeklaid, Pedlow, & Prior, 1991). Other investigators, however, placed a greater emphasis on determining how the interaction among child and parent factors may affect the development of self-regulation.

One approach recently used to examine how this interaction may affect the acquisition of regulative capacities by the child consists of determining whether parenting behaviors moderate the associations observed between temperament and specified aspects of child development. A study by Kochanska (1997) on the development of moral conscience elegantly illustrates this approach. Specifically, she finds that toddlers with a fearful temperament are more likely to develop moral conscience at preschool age when their mothers use gentle as opposed to harsh discipline (Kochanska, 1997). Conversely, probing a similar interaction, Gilliom and colleagues (2002) found that toddler's negative emotionality was a stronger predictor of ineffective self-regulation in a delay of gratification task when they were reared by mothers high in negative control and low in warmth. By contrast, for children with mothers low in negative control and high in warmth, negative emotionality was not related to ineffective self-regulation. Another example of the same approach is research by Hemphill and Sanson (2001) who reported that high reactivity at two years of age predicted high rates of externalizing behavior problems at four years only under conditions of poor parenting (i.e., low parental warmth, high punishment, low inductive reasoning).

A second approach currently used in this domain of research consists of treating child temperament as the moderator instead of parenting behaviors, and examining how child temperament affects the relations between parenting and behavioral outcomes. Belsky (1997a; 1997b) used it to suggest that the same developmental outcomes measured in different children may not reflect the effect of parenting practices to the same extent because infants differ in their susceptibility to the rearing environment. Inspired by this proposal, Feldman and colleagues (1999) showed that the relations

between early maternal sensitivity and various aspects of toddler's self-control were stronger for infants with a difficult temperament than for those with a relatively easy temperament. Specifically, they reported that mother-infant affect synchrony in play during the first year was a stronger predictor of compliance and of the ability to delay gratification at two years of child's age when the infant had been rated high on negative emotionality either via maternal report or by objective observations made in the laboratory. As suggested by Belsky, this research indicates that children high on negative emotionality are more susceptible to their rearing environment, such that for these children, the relations between parenting practices and child outcomes are more salient. A practical implication of this finding would be that infants who respond to the environment with high negative emotional arousal may be particularly in need of experiencing sensitive parenting if they are to develop proper self-regulatory skills.

For the most part, the current interest in probing the interactions between child negativity and parenting practices has been motivated by a need to understand better the conditions under which the effects of environmental risk factors on the emergence and development of problem behaviors may be amplified or minimized (e.g., Arcus, 2001; Belsky et al., 1998; Morris et al., 2002; Owens & Shaw, 2003). In this regard it is now well established that negative emotionality traits tend to exacerbate internalizing and externalizing problems as these traits predispose children to be more adversely affected by negative rearing environments (O'Connor, Caspi, DeFries, & Plomin, 2003; Rothbart & Bates, 2006). In comparison, there has been less attention devoted to designing research to examine how the same interactions between child and parent factors may foster adaptive developmental outcomes, such as effortful control.

Accordingly, one goal of the present research was to replicate the finding that maternal sensitive behaviors foster the development of effortful control in young children, and to extend this research by testing further the interactive effects of child negative emotionality and maternal sensitivity on the development of effortful control. The data set used for this purpose also afforded the possibility of exploring a three-way interaction among negative emotionality, sustained attention and maternal sensitivity. Proneness to distress, lack of attentional control, and lack of sensitive rearing could all be considered potential risk factors in the development of effortful control. Based on multiple-risk models that emphasize the joint occurrence of multiple individual and environmental risks (Rutter, 1979; Sameroff, Seifer, Baldwin, & Baldwin, 1993), a three-way interaction would likely reveal that children who were prone to negative emotionality in infancy would be at higher risk for developing poor effortful control capacities when there was neither the buffer of sustained attention nor that of maternal sensitivity.

It was hypothesized that maternal sensitivity functions as a general protective factor in the development of a capacity for effortful control. The interaction effects between negative emotionality and maternal sensitivity were examined from both directions. In a first analysis it was maternal sensitivity that was treated as a moderator of the relation between negative emotionality and effortful control. In a second analysis negative emotionality was posed as a moderator for the association between maternal sensitivity and effortful control. When maternal sensitivity was posited as a moderator, it was hypothesized that the adverse effect of negative emotionality on effortful control would vary depending on the quality of parenting. In this case, it was expected that the adverse effects of negative emotionality on the development of effortful control would be

attenuated when the child experiences maternal sensitive behaviors, and exacerbated when the rearing environment was not sensitive. On the other hand, when negative emotionality was considered as a moderator, the strength of the positive effect of maternal sensitivity on effortful control was expected to depend on the child's level of negative emotionality. Specifically, it was stipulated that a stronger positive association between maternal sensitivity and effortful control would be observed for children exhibiting high levels of infantile negative emotionality than for those with relatively low levels of negative emotionality. Finally, interactions among child negativity, sustained attention, and maternal sensitivity were expected to show that the adverse effect of child negativity on effortful control was strongest when the child lacked attentional control and the rearing environment was not sensitive.

#### 1.4 The Present Study

The main goal of the present study was to examine how the child's early temperamental predispositions, the caregiving environment, and the interactions among these factors shape the developmental pathways to effortful control in early childhood. This research was guided specifically by the following four sets of questions. (1) To what extent does early negative emotionality in infancy constrain the development of effortful control in early childhood? (2) Is sustained attention exhibited toward the end of the first year positively linked to effortful control? To what extent does sustained attention attenuate the effect of negative emotionality on effortful control? (3) Does sensitive parenting experienced in infancy foster the development of effortful control? And, how do negative emotionality and maternal sensitivity moderate each other's effects on the development of effortful control in early childhood? (4) How do the interactions among

negative emotionality, sustained attention, and maternal sensitivity shape the development of effortful control?

Longitudinal data from the Durham Child Health & Development Study were used to examine these questions. In this study, negative emotionality was assessed at six months of child age using the Arms Restraint procedure in the laboratory and the distress to limitation dimension obtained from the Revised Infant Behavior Questionnaire. Global ratings of sustained attention were obtained during parent-child free play at twelve months of age. Observer-rated measures of maternal sensitivity were obtained at six months during mother-child interactions. The outcome, effortful control, was measured via maternal ratings on the Children's Behavior Questionnaire, in a delay of gratification paradigm, and a battery of inhibitory control tasks at 36 months. This last set of measures assessed effortful control — a capacity to inhibit a predominant response in order to initiate a subdominant one, through maternal perceptions, its effect on behavioral regulation, and its support of cognitive processes.

The data were subjected to both variable-oriented and person-oriented analyses. Variable-oriented approaches attempt to capture developmental processes via the patterns of association discernible among specific factors within the sample as a whole, while person-oriented approaches do so by examining how the same factors are differentially patterned within subgroups of individuals (Magnusson, 1998; Magnusson & Cairns, 1996). Magnusson & Bergman (1988) recommended to routinely complement these two approaches in developmental studies. In the present research, a variable-oriented approach was used to assess the joint effects of child and environmental factors on effortful control measured in early childhood, while a person-oriented approach was

applied to examine how group differences in this outcome may be predicted by specific configurations of the same factors in different subgroups.

The specific hypotheses that guided this research were the following. First, a longitudinal link between early negative emotionality and later effortful control was expected, such that six-month-old infants who were prone to negative emotionality should experience difficulty in developing effortful control in early childhood. Sustained attention, on the other hand, was predicted to be positively associated with the development of effortful control. Moreover, sustained attention was expected to largely attenuate the adverse effect of early negative emotionality on later effortful control. A combination of proneness to negative emotionality and poor sustained attention was expected to be more detrimental to the acquisition of effortful control than the occurrence of only one or none of these factors. Furthermore, maternal sensitivity was hypothesized to foster the development of effortful control. However, maternal sensitivity and negative emotionality were expected to moderate each other's effects. Specifically, maternal sensitivity was predicted to moderate the adverse effect of negative emotionality, such that the negative impact of this child factor would be largely attenuated by maternal sensitivity. Conversely, the strength of the positive association between maternal sensitivity and effortful control was hypothesized to vary depending on the level of negative emotionality, with stronger associations expected between maternal sensitivity and effortful control for children prone to negative emotionality in infancy. Lastly, it was posited that children who were prone to negative emotionality would be at higher risk for developing poor effortful control capacities if they neither had good attentional control nor experienced maternal sensitivity. The combination of a proneness to negative emotionality, poor sustained attention, and the lack of a sensitive rearing environment was expected to be the most detrimental to the development of effortful control, compared to any other configuration of the same factors.

#### II. METHOD

#### 2.1 Participants

This study was drawn from a longitudinal study of mothers and their children assessed at 3, 6, 12, 18, 24, 30, and 36 months of child age. Participants (206 families) were recruited at 3 months of child age for the Durham Child Health and Development (DCHD) Study. Distributed across levels of income and education, these families came from the greater Durham area in North Carolina, and were specifically recruited to represent an approximately equal number of European and African American families. Ethnicity was determined through maternal report as African American or European American. Precautions were taken to ensure that participating infants were developing normally and had no pre- or post-natal medical histories that could pose a risk to healthy development. Parents were recruited to the study via fliers and postings in the hospitals where they gave birth, parenting classes, and through phone contacts from birth records. Qualified families were informed of the nature of the study and their right to discontinue participation should they choose to. Informed consent was obtained during the first visit.

Sample Characteristics. Families were classified as below or above poverty level using a cutoff point set at two times above the federally established threshold. Using this standard, 48.5% of the families were classified as living above the poverty level, while the remaining 51.5% were below poverty. In the sample as a whole, 55% were African American and 44% were European American. The remaining 1% was classified as "other". Formal education among the participating mothers varied widely, with 14%

having no high school degree, 18% having a high school diploma or G.E.D., 22% with some college or vocational school experience, 29% with a four-year bachelor's degree, and 17% having received education beyond a bachelor degree. The 206 children involved in the study were males and females in nearly equal proportions (51.5% and 48.5% respectively).

#### 2.2 Procedure

#### 6-Month Home Visit

At 6 months of child age, a 2-hour home visit and a 2-hour laboratory visit were scheduled for each family. During the home assessment, mothers completed the Revised Infant Behavior Questionnaire (IBQ-R, Gartstein & Rothbart, 2003). They were also videotaped in a semi-structured 10-minute free play session with their child. For this purpose, the pair was asked to sit on a blanket laid out on the floor, and the mother was given a standard set of age-appropriate toys she could use in play with her infant. These toys included an electronic busy board, musical stacking rings, and a plastic phone. The mother was instructed to play with her child as she normally would given some free time during the day.

#### 6-Month Laboratory Visit

The 6-month laboratory visit typically occurred within one week of the 6-month home visit. During this visit, the mother and her child participated in two challenge tasks that included the Still Face paradigm (Tronick, Als, Adamson, Wise, & Brazelton, 1978) and the Arms Restraint procedure (Goldsmith & Rothbart, 1996). The mother was instructed to secure her infant in a car seat located on top of a large wooden table and asked to sit on an adjustable stool in front of the car seat. After the Still Face paradigm,

she was instructed to turn her head away from her child while gently holding his or her arms down with enough pressure to prevent arm movements. This procedure lasted for 60 seconds, after which the mother was instructed to interact with her child as she normally would for 2 minutes. The two procedures were filmed using two cameras, one aimed at the infant's face and body and the other at the mother's face and upper body. Because many children experienced this period as highly distressing, mothers were informed in advance that they could interrupt either procedure at any point and take their child out of the car seat if they wanted. The experimenter also discontinued them if the child became upset and cried for more than 20 seconds. If the child recovered within a couple of minutes, an attempt was made to resume with the permission of the mother. Otherwise, the experimenter moved on to the next task.

#### 12-Month Laboratory Visit

During the 12-month laboratory visit mothers and children were videotaped in another free play session for 10 minutes as they had been at the previous 6-month home visit. The pair was similarly asked to sit on a blanket laid out on the floor, the mother was given a standard set of age-appropriate toys that she could use in play with her child, and was instructed to do so as she normally would given some free time at home.

#### 36-Month Laboratory Visit

Two laboratory visits were scheduled at 36 months of child age. In the first visit, mothers completed the Children's Behavior Questionnaire (Rothbart et al., 1994; Rothbart et al., 2001) and their child participated in a delay of gratification task (i.e., the wrapped gift task).

Wrapped Gift task (Kochanska et al., 2000). This task begun with the experimenter entering the room with a gift and wrapping supplies concealed in a paper bag. The child was asked to sit on a chair with his or her back to the experimenter. The experimenter, located behind the chair, wrapped the gift on the floor and asked the child to try not to peek while the gift was being wrapped (60 seconds). Then the experimenter placed the gift on the table in front of the child within reaching distance, and asked the child to not touch it until she eturned with a bow (2 minutes). If the child did not open the gift completely at the end of the two minutes, the experimenter returned with a bow and the child could open the gift. If the child opened the gift completely within 2 minutes, the experimenter returned at that time. During this task, the mother was asked to sit at a distance from her child reading a magazine and to ignore any request made to her by her child. The entire 3-minute session was videotaped.

In the second visit at 36 months, the children participated in three inhibitory control tasks that included the Unicorn-Dragon Puppets, the Day-Night task, and the Grass-Snow task.

Unicorn-Dragon Puppets (Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996; Reed, Pien, & Rothbart, 1984). The experimenter introduced two puppets (one unicorn and one dragon) to the child and let him/her become acquainted with the puppets. The child was then told that they were going to play a game in which s/he should do what the "nice" unicorn said and not do what the "mean" dragon said. While holding the puppets at the same height, the experimenter made requests to the child to execute simple actions (e.g., touch your nose, touch your ears, clap your hands, etc.). Practice trials were administered until the child correctly responded to one unicorn request and refrained

from responding to one dragon request. During the practice trials, corrective prompts were offered as needed. If the child was unable to achieve success after 5 practice trials involving each puppet, the task was terminated. Otherwise, 10 "unicorn" and 10 "dragon" requests were made for a total of 20 test trials. The child was given three seconds to respond to each request. No feedback was given after the practice trials ended.

Day-Night task (Gerstadt, Hong, & Diamond, 1994). The experimenter first engaged the child in a conversation about when the sun came up (in the day) and when the moon and stars came out (in the night). The experimenter then presented to the child a white card with a yellow sun drawing on it and a black one with a white moon and stars. The child was told that they were going to play a game in which s/he was asked to say "night" when the white card with the yellow sun was presented, and to say "day" when the black card with moon and stars was presented. Practice trials were administered until the child successfully labeled each card correctly once. During the practice trials, corrective prompts were offered as needed, and requests for a response were made if the child did not respond. If the child was unable to demonstrate success after 5 practice trials with each day/night card, the task was terminated. Otherwise, 10 "day" and 10 "night" cards were shown in a predetermined random order, the same for each child, for a total of 20 test trials. No feedback was given after the practice trials ended.

Grass-Snow task (Carlson & Moses, 2001). This third task was analogous to the day-night task, except that the child was asked to respond by pointing instead of verbally. The experimenter first engaged the child in a conversation about the color of the ground during the summer when grass was growing (green), and during the winter when it was covered with snow (white). The purpose was to establish that grass was green and snow

was white. Then, a white card and a green one were placed on the table and the child was told that they were going to play a game in which s/he should point to the green card when the experimenter said "snow" and point to the white card when she said "grass." Practice trials were administered until the child successfully pointed to each card correctly once. During the practice trials, corrective prompts were offered as needed, and requests for a response were made if the child did not respond. The task was terminated when the child did not achieve success after 5 practice trials with each grass/snow card. If the child was successful, 10 "grass" and 10 "snow" statements were issued in a predetermined random order, the same for each subject, for a total of 20 test trials. No feedback was given after the practice trials ended.

#### 2.3 Constructs and Measures

#### Demographics.

The *child's ethnicity* and *sex* were obtained during the initial screening interview with the mother. Mothers also reported the highest level of *education* they had received, their total household income, and the size of their family/household at the time of the sixmonth home visit. An *income-to-needs ratio* was calculated by dividing the reported household income by the federally determined poverty threshold for families of different sizes. Income-to-needs ratios above one indicated that a family was deemed able to provide for basic needs, while ratios below one indicated that the family was not earning a sufficient income to meet basic costs of living.

### Effortful Control

Temperament assessment. Child temperament was measured in the DCHD study using the short form of the CBQ (Rothbart et al., 1994; Rothbart et al., 2001). This

instrument, designed for children aged 3 to 7 years, contains 94 items and 14 subscales. For each item, mothers rated the degree to which its statement was an accurate description of their child's reactions and behaviors within the past six months (1 =extremely untrue to 7 = extremely true). Using factor analysis, Rothbart et al. (2001) identified a general factor of effortful control that was distinct from factors of extraversion/surgency and negative affectivity. Four subscales loaded on the effortful control factor that included attention focusing, inhibitory control, low intensity pleasure, and perceptual sensitivity. This factor was labeled "effortful control" because all of its component subscales described aspects of children's voluntary regulation of attention and behavior. Sample items of these four subscales are: "When building or putting something together, s/he becomes very involved in what s/he is doing, and works for long periods", "S/he can wait before entering into new activities if s/he is asked to", "S/he enjoys gentle rhythmic activities, such as rocking or swaying", and "S/he is quickly aware of some new item in the living room". These subscales of the original CBQ-Long Form had internal consistencies ranging from .67 to .94 (Rothbart et al., 1994). In the present study, the corresponding standardized Cronbach's alpha was .72 for attention focusing (6 items), .65 for inhibitory control (6 items), .72 for low intensity pleasure (8 items), .63 for perceptual sensitivity (6 items). Further, principal component factor analysis showed that these four subscales loaded positively and highly on one single factor: attention focusing (.77), inhibitory control (.78), low intensity pleasure (.62), and perceptual sensitivity (.65). This single factor accounted for 50.24% of the variance with an eigenvalue of 2.01. Thus, a composite CBQ effortful control score was computed by averaging the raw scores of these four component subscales, with a Cronbach's alpha of .83 (26 items).

Wrapped Gift task. The first section of the gift-wrapping task yielded three measures including latencies to turn and peek (ranging from 0 to 60 seconds) and a peek score (1 = turns body around to look and never returns fully forward, 2 = turns body around to look but eventually turns back forward, 3 = peeks over shoulder far enough to see the gift being wrapped, 4 = turns head to side but not enough to see the gift being wrapped, 5 = never turns around to peek). Interrater reliabilities were calculated on the basis of a random selection of 20% of the sample that was coded independently by three observers. The average weighted kappa across pairs of coders was .84 for the peek score. The average intraclass correlation (ICC) among coders was .83 for latency to turn, and .78 for latency to peek. The peek score and latency measures were significantly intercorrelated (mean r = .73, p < .0001). Thus, a composite peeking score was created by averaging the standardized peek score and latencies to turn and peek. A high score on this composite indicated that the child was less likely to peek and better able to keep attention away from the tempting gift.

During the waiting-for-the-bow portion of the procedure, coders recorded latencies (ranging from 0 to 120 seconds) to touch, lift, and open the gift. A touch score was also recorded using a 4-point scale (1 = opens the gift, 2 = lifts or picks up the gift, 3 = touches the gift without lifting or opening it, 4 = does not touch the gift at all). Interrater reliability statistics were similarly computed on the basis of a random selection of 20% of the sample that was independently coded by the three observers. The weighted kappa for the touch score averaged .89 across pairs of coders. The average ICC was 1.00 for latency to touch, .94 for latency to lift, and .92 for latency to open. The touch score and latency measures were significantly intercorrelated (mean r = .68, p < .0001). Thus, a composite

delay score was created by averaging the standardized touch score and latencies to touch, lift, and open the gift. A high delay score indicated that the child was more likely to inhibit his/her impulse and to refrain from touching the gift.

Unicorn-Dragon Puppets. For this task, 87% of the children achieved success during the practice trials and thus participated in the test trials. It is worth noting that the data from this task were not likely to be missing at random, because absence of data may signify that the child's capacity of inhibitory control was low. For this reason, imputation of missing data was not attempted. The same logic applies to the other two inhibitory control tasks. Each "unicorn" prompt was scored using a 4-point rating scale (0-3) with 0 = 1 failure to move, 1 = 1 a wrong movement/flinch, 1 = 1 partial correct movement, and 1 = 1 full correct movement. The "dragon" trials were similarly scored as 1 = 1 a wrong movement/flinch, and 1 = 1 a partial commanded movement, 1 = 1 a wrong movement/flinch, and 1 = 1 and movement. A proportion of correct responses across test trials was computed for each child, with a high percentage indicating a better performance on the task.

Day-Night task. For this task, 86% of the children achieved success during the practice trials and thus participated in the test trials. One point was given for each correct answer. The proportion of correct responses across test trials was computed for each child, with a high percentage indicating a better performance on the task.

*Grass-Snow task*. For this task, 77% of the children achieved success during the practice trials and thus participated in the test trials. The child received 1 point for every time s/he pointed to the correct card. A proportion of correct responses across test trials

was computed for each child, with a high percentage indicating a better performance on the task.

Negative Emotionality and Reactivity

Distress to Limitation. The Distress to Limitation dimension of the IBQ-R (Gartstein & Rothbart, 2003) reflected maternal perceptions of infant negative emotionality at 6 months. Although the validity of parent reports of temperament has often been questioned (e.g., Kagan, 1994; Kagan, 1998), they are still considered a useful estimate of child temperament because parents have the advantage of being able to observe their child on multiple occasions and across different contexts in daily life (Rothbart & Bates, 2006).

The *Distress to Limitation* dimension consists of 16 items that mothers rated on a 7-point scale ranging from "never" (1) to "always" (7) based on their child's reactions and behaviors during the past seven days. Sample items include, "After sleeping, how often did your child fuss or cry immediately?", "How often did your child seem angry (crying and fussing) when you left her/him in the crib?", and "When something your child was playing with had to be removed, how often did s/he cry or show distress for a time?" A composite score of "Distress to Limitation" was calculated by averaging the scores of the items that comprised this dimension (with some items reverse-coded when necessary). This composite score was not computed if more than 20 percent of the item scores were missing. The original IBQ was standardized using 450 informants (Rothbart, 1981). The internal consistency of this instrument is quite high, ranging from .70 to .90 across its different dimensions (Gartstein & Rothbart, 2003). In the present study the standardized Cronbach's alpha of the *Distress to Limitation* scale was equal to .82.

Arms Restraint procedure. Child negative affect during the arms restraint procedure was coded in 5-second intervals using a 3-point scale adapted from previous research (Haley & Stansbury, 2003). A score of 1 was given for intervals during which the child displayed little or no negative affect. If the child showed a mild level of negativity (such as fussiness, mild protesting, or pouting), a score of 2 was entered. A score of 3 represented a high level of negativity (such as crying, venting, or intense protest). Twenty percent of the sample was double coded to ensure interrater reliability. The average ICC was .89 among coders. A global negative affect score was calculated for each child as the percentage of 5-second blocks rated as 3 during this procedure. This variable represents the proportion of time during which the child showed high levels of distress in this procedure at six months.

# Maternal Sensitivity

Maternal sensitive behaviors during mother-child interactions were rated using five 5-point scales at 6 months (Cox & Crnic, 2003). These scales were revisions of those developed for the NICHD Study of Early Child Care (NICHD Early Child Care Research Network, 1999) and included sensitivity/responsiveness, detachment/disengagement, positive regard for the child, animation, and stimulation of development. The coders who scored the videotaped interactions were blind to all other information about the families. A master coder trained all other coders until excellent interrater reliability was achieved for each scale. Once reliability was achieved, non-master coders observed in pairs or independently while continuing to code at least 20% of the cases with the master coder. All mother-child interactions (i.e., 100%) were double coded. For all cases a final consensus score was recorded for each scale. Interrater reliabilities, calculated by the

single measure ICC using scores from all double-coded cases, are given below respectively for each of the five global scales.

The sensitivity/responsiveness scale, adapted from Ainsworth, Blehar, Waters, & Wall (1978), rated how the mother responded to the child's distress as well as non-distress. A defining characteristic of a sensitive interaction is that it is child-centered. The average reliability for this scale across pairs of coders was .78. The detachment/disengagement scale rated the degree to which the mother was emotionally distant, uninvolved, and unaware of the child's needs and the appropriate actions to meet those needs. The average reliability for this scale was .82. The positive regard scale rated both the quantity and quality/intensity of the mother's verbal and physical expression of positive feelings toward the child during the interaction. The average reliability for this scale was .80. The animation scale rated the extent to which the mother displayed vocal and affective energy, excitement, or interest during the interaction. The average reliability for this scale was .76. The stimulation of development scale rated the degree to which the mother engaged in age-appropriate development fostering behaviors with the child. The average reliability for this scale was .75.

Exploratory factor analysis showed that the above five scales loaded on one single factor (standardized Cronbach's alpha = .88). Previous research (e.g., Egeland, Kalkoske, Gottesman, & Erickson, 1990) suggests that composites of global ratings of parent-child interaction often have better psychometric properties including better validity and reliability than individual scales. Thus, based on factor analysis, a composite of maternal sensitivity was formed by averaging the cale scores for sensitivity, positive regard, animation, stimulation of development, and a reverse coding of detachment. The mean of

the single ICC measure for this composite of maternal sensitivity across pairs of coders was .89.

#### Sustained/Focused Attention in Mother-Child Interaction

Child's sustained/focused attention during mother-child interactions at 12 months was rated using a 5-point global rating scale (Cox & Crnic, 2003), revised from scales developed for the NICHD Study of Early Child Care (NICHD Early Child Care Research Network, 1999). Past research has demonstrated the utility of mother-child free play in assessing children's attention skills (e.g., Lawson & Ruff, 2004; Ruff, Lawson, Parrinello, & Weissberg, 1990). Further, studies have shown that global ratings of child attention that take into account context and subtle cues from different behaviors, may capture more information than single quantitative indexes of attentional behavior (e.g., duration of focused attention). As a result, global ratings of the quality of child attention can potentially have better predictive value than specific quantitative indexes (Lawson & Ruff, 2004; Ruff et al., 1990; Ruff & Rothbart, 1996).

The *sustained/focused attention* scale rated the extent to which the child was able to sustain his/her attention when interacting with objects during free play with the mother. Coders took into consideration gaze, facial expressions, and behaviors indicative of attempts to initiate contact with objects and to manipulate and explore them. Sustained attention may also be demonstrated by the relative intensity with which an object was focused upon and explored. High intensity focus was typically marked by eye gaze accompanied by activities, such as looking at the object while banging it. Intense exploration involved multiple behaviors directed at the same object(s) (e.g., looking, licking, twisting in hands, etc.). Conversely, a child who lacked sustained attention

appeared apathetic, bored, distracted, or distressed. A score of 1 was given if the child focused very little and displayed very few attempts to initiate contact with objects. A score of 2 was given if the child exhibited some periods of attention to objects or activities, but these instances were very brief and the intensity of the attention was weak. A score of 3 was assigned if the child remained involved for relatively longer periods of time, but lost attention or explored less completely when involved with objects. A score of 4 was given if the child manipulated and explored objects with sustained attention for the most part, displaying only brief instances of inattention. A score of 5 was assigned if the child remained involved, interested, and, through his/her own intense attention, maintained a high level of exploration and manipulation of the objects available to him/her for the majority of the time. Ratings were context-sensitive, such that a child would still receive a high score of sustained attention in spite of being with an intrusive mother who presented toys at a rapid pace, if s/he continued trying to attend to the objects and remained involved and interested. All cases were double coded, and the mean of the single ICC measure for this scale across pairs of coders was .80.

#### 2.4 Data Reduction

Principal component factor analysis showed that multiple measures of the construct of effortful control loaded positively with moderate to high loadings on one single factor. The factor loadings were .44 for the CBQ effortful control score, .73 for the peeking composite score and .80 for the delay composite score in the delay of gratification task, and .58 for the proportion of correct responses in the unicorn-dragon task. This single factor accounted for 42% of the variance with an eigenvalue of 1.70. Thus, an effortful control composite score was computed by averaging the standardized scores of the above

four measures, and was subsequently used as the outcome variable in the following analyses. This effortful control composite was highly correlated with all of its component variables, as shown in Table 1. The respective correlations were .64 (p < .0001) with the CBQ effortful control score, .68 (p < .0001) with the peeking composite score, .78 (p < .0001) with the delay composite score, and .61 (p < .0001) with the proportion of correct responses in the unicorn-dragon task. It is worth noting that the proportion of correct responses in the day-night task and that in the grass-snow task did not load on this factor, and they were not correlated with each other, or with any other measure of the construct of effortful control (see Table 1). Hence, data collected from these two tasks were excluded from all of the following analyses.

Also, there was no significant correlation between the two measures of negative emotionality, i.e., the distress to limitation scale of the IBQ-R at six months, and the proportion of time during which child showed high levels of distress in the arms restraint procedure at six months (r = -.009, p = .91). This is not entirely surprising, because the first measure was derived from maternal perceptions formed over time and contexts, while the second was obtained by expert observers who assessed child negative affect only once and in a single controlled context. Therefore, these two measures of negative emotionality were used separately in the following analyses.

### 2.5 Data Analysis Plan

The research questions and their corresponding hypotheses were examined through the lens of two analytical strategies. First, separate regression analyses were conducted to determine whether the observed child and/or environmental variables, independently or in interactions, predicted effortful control. Second, latent class analysis was used to identify naturally occurring configurations of the predictor variables that may be associated with significant differences in effortful control.

# 2.5.1 Multiple Linear Regression Analysis Plan

The regression analyses were conducted using the SAS system for Windows Version 9.1. Relevant demographic variables were entered into all regression equations as control variables, including child ethnicity, child sex, and maternal education. Significant interactions were probed using the pick-a-point procedure (Aiken & West, 1991) that examines the relation between the outcome variable and one predictor at different levels (two for dichotomous variables, three for continuous variables) of a proposed moderating variable.

To examine the extent to which early negative emotionality constrains the emergence of effortful control in early childhood, a multiple linear regression (MLR) was conducted with effortful control as the dependent variable and negative emotionality and the demographic variables as the independent variables. Although negative emotionality may constrain the development of effortful control, the extent of this effect may also depend on the child's capacity to sustain attention at 12 months of age. To test this proposition a MLR was conducted with effortful control as the dependent variable and sustained attention and demographic variables as the independent variables. Further, to investigate the extent to which sustained attention may attenuate the effect of negative emotionality on effortful control, negative emotionality and an additional term representing the interaction between negative emotionality and sustained attention were entered into the equation. If significant, this interaction was probed with sustained attention treated as a moderating variable.

The next series of analyses considered the role of the environmental variable. Specifically, to examine if maternal sensitivity fosters the development of effortful control, a MLR was conducted with effortful control as the dependent variable and maternal sensitivity and demographic variables as the independent variables. Then, to determine if negative emotionality and maternal sensitivity moderated each other's effects on the development of effortful control, negative emotionality and an additional term representing the interaction between negative emotionality and maternal sensitivity were entered into the equation. If significant, this interaction was probed and examined in two ways: first by treating maternal sensitivity as the moderator, and second by posing negative emotionality as the moderator.

Lastly, I tested the hypothesis that beyond their main effects the interactions among the three predictor variables (i.e., negative emotionality, sustained attention, and maternal sensitivity) also contributed to the development of effortful control. Thus, in a stepwise fashion, these variables were entered first along with the demographic variables, then in a second and third steps respectively, the two-way interactions among the three predictor variables and their three-way interaction were entered. The highest order significant interaction(s) was probed, with sustained attention and/or maternal sensitivity as the moderator(s).

### 2.5.2 Latent Class Analysis Plan

The variable-oriented approach described above is based on the assumption that variability in a specified outcome can be accounted for through the independent and interaction effects of presumed predictor variables. Yet, from a systems approach (Sameroff, 1983), it is only in the context of its association with other variables that a

specific variable acquires its predictive value. Thus, through latent class analysis (LCA, Lazarsfeld & Henry, 1968) I aimed to identify naturally occurring configurations of predictor variables that may be associated with significant differences in the specified outcome measure. Note, however, that by its very nature a person-oriented analysis fused into a single question the set of four that were of interest to the present research. Namely, were there naturally occurring configurations of the variables of interest to the present study that predicted effortful control at 36 months? This did not mean, on the other hand, that the corresponding hypotheses could not be tested. For instance, if, as postulated, infantile negativity had stronger adverse effects on effortful control when maternal sensitivity and child sustained attention were low, LCA should identify a subgroup of children that not only exhibited this profile but also scored significantly lower on the measures of effortful control than did other groups.

LCA is a specific type of latent variable mixture model or finite mixture model where the observed distribution is assumed to comprise mixtures of two or more underlying distributions (Muthén, 2001; 2004). Thus, contrary to standard clustering techniques that use a similarity matrix to force the objects to be clustered into specific groups, LCA assigns each subject a probability of belonging to each group. A more comprehensive review of LCA and its technical details can be found in Muthén (2004). For the purpose of the present research LCA was applied to test whether meaningful subgroups of children could be identified that differ in their observed scores of negative emotionality, sustained attention, and maternal sensitivity.

LCA models were fitted within a SEM framework using Mplus 3.12 (Muthén & Muthén, 2003). I began with a baseline one-class model and proceeded to test models

with successively higher numbers of classes. Relative model fit was evaluated using various fit criteria that included Bayesian information criteria (BIC, Raftery, 1995; Schwartz, 1978), Akaike information criterion (AIC, Akaike, 1974), entropy, and Lo-Mendell-Rubin likelihood-ratio test (LMRLRT, Lo, Mendell, & Rubin, 2001). Both BIC and AIC balance model complexity and goodness of fit to the sample data, with smaller values representing better fit. Entropy refers to the average classification accuracy when assigning participants to classes, with values (ranging from 0 to 1) closer to 1 indicating greater precision. LMRLRT provides a direct test between two models, with a low p-value indicating that a k-1 class model should be rejected in favor of a model with at least k classes.

Next, plots were generated to visually examine and compare the person-profiles heretofore identified with regard to their respective scores on infant negativity, child focused attention, and maternal sensitivity. Tests of my hypotheses consisted of using t-tests and regression analyses to determine whether there existed significant differences in effortful control among these subgroups, and whether these differences were found between profiles that reflected the interaction effects hypothesized at the outset of this study.

# III. RESULTS

## 3.1 Sample Demographics and Descriptive Statistics

The bottom part of Table 1 presents the descriptive statistics for each of the research variables specified for this study. The top part reports the bivariate correlations observed among them in the data set. Two of the demographic variables, child race/ethnicity and maternal education were correlated (r = .34, p < .0001), indicating that African American mothers in this sample received less formal education than European American mothers.

Correlations with the demographic variables. A number of correlations among the demographic and the predictor and outcome variables were observed. Correlations with race/ethnicity showed that African American mothers tended to rate their child higher on the IBQ-R distress to limitation scale than did European American mothers (r = -.23, p = .002). Also, maternal sensitive behaviors displayed in free play at six months of child age tended to be higher among European American mothers (r = .31, p < .0001). Moreover, mothers with less education tended not only to rate their child higher on the IBQ distress scale (r = -.18, p = .019) but also to have children who spent a larger proportion of time in high levels of distress in the arms restraint procedure at six months (r = -.21, p = .01). Mothers with less education also tended to be less sensitive in free play (r = .51, p < .0001). There was a significant gender difference in sustained attention with girls tending to display lower levels of focused attention than boys in free play with their mothers at 12 months (r = -.17, p = .035). Finally, the outcome variable, the

effortful control composite score, was significantly correlated with all three of the demographic variables. European American children scored higher on this variable than African American children (r = .24, p = .001), so did girls as compared to boys (r = .30, p < .0001), and did children whose mothers had more formal education as compared to children of less well-educated mothers (r = .37, p < .0001).

Correlations among the predictor variables. There was a significant negative correlation between maternal IBQ-R ratings of child distress and maternal sensitive behaviors observed during free play at six months of child age (r = -.23, p = .002). Children with more sensitive mothers received lower distress ratings than did children with less sensitive mothers.

Correlations involving the outcome variable. As mentioned above, the effortful control composite, the outcome variable, was significantly correlated with all three of the demographic variables. Other than these, only two correlations were observed that involved this variable. The first was maternal sensitivity, which was positive, indicating that mothers who were more sensitive in free play with their six-month child had children who scored higher on effortful control at 36 months (r = .27, p = .0005). The second correlation showed that children whose mothers rated them higher on distress at six months tended, but only marginally, to score lower on this global measure of effortful control (r = -.15, p = .059).

#### 3.2 Diagnostics

Prior to data analysis, all variables were examined to ensure that they met the requirements specified by the analytical techniques to which they were subjected. The bivariate correlations presented in Table 1 indicated no evidence of multicollinearity

among the independent variables. Also, as shown in Figure 1, the outcome variable — the effortful control composite score was fairly normally distributed in the sample. Furthermore, no clear outliers were identified in the bivariate scatter plots presented in Figure 1 (outcome and demographic variables) or Figure 2 (outcome and predictor variables).

Prior to running analyses, all continuous independent variables were mean centered to facilitate the probing of significant interactions and their interpretation. In fact, centering variables can also reduce multicollinearity in the context of regression analysis with higher order terms (Aiken & West, 1991).

- 3.3 Multiple Linear Regression Analyses
- 3.3.1 Negative Emotionality and Sustained Attention

Model 1 - Three-Way Interaction among High Distress in Arms Restraint, Sustained Attention and Child Sex

Results from the five MLR models are presented in Table 2. Model 1 examined the interaction effect of high distress in the arms restraint procedure at six months, sustained attention at 12 months and child sex on effortful control at 36 months. This model was highly significant (F(11, 104) = 5.13, p < .0001) and accounted for approximately 35% (Adjusted  $R^2 = .28$ ) of the variation observed in effortful control (see Model 1 in Table 2). As seen in Table 2, the sex of the child was a significant predictor of effortful control. I had initially hypothesized that the negative effect of child distress on effortful control might be attenuated by child sustained attention. A significant three-way interaction involving these two measures and child sex demanded to examine this relation further.

The pick-a-point method (Aiken & West, 1991) was used to examine this interaction. The values of the slopes representing the relation between high distress in arms restraint and effortful control were tested at six different combinations of child sex (i.e., male or female) and sustained attention (i.e., one SD below the mean, at the mean, and one SD above the mean). Two of these conditions significantly affected the relation between high distress and effortful control. As seen in Figure 3, girls who spent a larger proportion of time in high distress while in arms restraint and whose sustained attention was either below or at the average tended to score higher on effortful control at 36 months (b = .011, p = 0, and b = .0055, p = .0009, respectively).

Model 2 - Three-Way Interaction among High Distress in Arms Restraint, Sustained Attention and Maternal Education

This model examined the interaction effect of high distress in the arms restraint procedure at 6 months, sustained attention at 12 months, and maternal education on effortful control at 36 months. This model was highly significant (F(11, 104) = 4.92, p < .0001) and accounted for approximately 34% (Adjusted  $R^2$  = .27) of the variation observed in effortful control (see Model 2 in Table 2). Maternal education was a significant predictor of this outcome (b = .081, p = .0155). Children whose mothers were better educated scored higher on the effortful control composite than did children whose mothers had less education. Although both the proportion of time in high distress and maternal education independently affected the outcome, these effects were further qualified by a three-way interaction among these two variables and sustained attention in free play.

Once again, the pick-a-point method was used to examine this interaction. The values of the slopes representing the relation between high distress and effortful control

were tested at nine different combinations of sustained attention (i.e., one SD below the mean, at the mean, and one SD above the mean) and maternal education (i.e., one SD below the mean, at the mean, and one SD above the mean). As shown in Figure 4, the slope defining this relation differed significantly from zero under five of these nine conditions. When maternal education was below the mean, significant gains in effortful control were evident if the child's sustained attention was above the mean (b = .0064, p = .0169). It is worth noting, however, that this effect, albeit significant, was detected on the basis of only a few data points in this sample. More robust effects were observed in the remaining four conditions. When maternal education was at average, the slope was positive and significant when sustained attention was either below the mean (b = .0061, p = .0024) or at the mean (b = .0042, p = .0026). Similar gains were observed for the same ranges of sustained attention when maternal education was above the mean (attention below average: b = .012, p = .0001; attention at average: b = .0051, p = .0155). Thus, children showing high distress while in arms restraint and who were below or at the mean in sustained attention made positive gains in effortful control when maternal education was at or above the sample average.

### 3.3.2 Negative Emotionality and Maternal Sensitivity

Model 3 - Three-Way Interaction among IBQ-R Distress to Limitation, Maternal Sensitivity and Maternal Education

The regression model designed to examine the interaction effect of the IBQ-R distress to limitation scores at six months, maternal sensitivity at six months, and maternal education was highly significant (F(9, 145) = 7.87, p < .0001) and accounted for approximately 33% (Adjusted R<sup>2</sup> = .29) of the variation in effortful control at 36 months

(see Model 3 in Table 2). Effortful control was significantly predicted by child race (b = .22, p = .0472) and child sex (b = .49, p < .0001). These effects indicated that European American children scored higher on effortful control than African American children did, and that girls performed better than boys did in this regard. This model also showed independent and positive effects of both maternal sensitivity and maternal education as well as a negative but marginal contribution of distress to limitation. The main effects of these predictors on effortful control were further qualified by a three-way interaction involving distress to limitation, maternal sensitivity, and maternal education.

Using the pick-a-point method this interaction was probed in two different ways by treating alternatively maternal ratings of child distress and maternal sensitivity as the independent variable. First, with distress to limitation as the independent variable, effortful control scores were examined at nine different combinations of maternal sensitivity (i.e., one SD below the mean, at the mean, and one SD above the mean) and maternal education (i.e., one SD below the mean, at the mean, and one SD above the mean). Significant changes in the outcome variable were observed under two of these conditions. As shown in Figure 5, high levels of distress to limitation negatively impacted the development of effortful control only when maternal education was below the mean and maternal sensitivity was either at average (b = -.25, p = .0011) or above average (b = -.44, p = .0003). It is worth noting that the slope of the regression line corresponding to this second case, although significantly different from zero, was derived from only a few data points. Accordingly, it is prudent to interpret the results of this third regression model as suggesting that higher ratings on child distress to limitation predicted lower effortful control at 36 months only for children with mothers who received less than an

average level of education and who displayed no more than average sensitivity in free play with their six-month-old.

Next, with maternal sensitivity as the independent variable, the same three-way interaction was probed under nine different combinations of distress to limitation (i.e., one SD below the mean, at the mean, and one SD above the mean) and maternal education (i.e., one SD on below the mean, at the mean, and one SD above the mean). Maternal sensitivity predicted significant changes in effortful control in five of those nine conditions. As shown in Figure 6, with maternal education below the mean, increases in maternal sensitivity imparted significant gains in effortful control when ratings of distress to limitation were below the mean (b = .30, p = .0078). At average values of maternal education, a similarly positive effect was observed when distress to limitation was either below (b = .18, p = .0209) or at the mean (b = .16, p = .0179). And finally, with maternal education above the sample mean, positive gains in effortful control were observed at higher values of maternal sensitivity even when ratings of child distress were at the mean (b = .23, p = .0154) or above the mean (b = .40, p = .0074). In summary, these analyses indicate that increases in maternal education appear not only to augment the protective effects of maternal sensitivity in the acquisition of effortful control, but also to extend this benefit to the highest levels of child distress.

Model 4 - Three-Way Interaction among High Distress in Arms Restraint, Maternal Sensitivity and Maternal Education

The final set of regression analyses by which I examined my initial hypotheses modeled the effects of high distress in the six months arms restraint procedure, maternal sensitivity at six months, maternal education, and the interactions among these factors on effortful control. This last model (Model 4, Table 2) was highly significant (F(9, 128) =

6.79, p < .0001) and accounted for approximately 32% (Adjusted R<sup>2</sup> = .28) of the variation observed in effortful control at 36 months (see Model 4 in Table 2). The model showed that girls scored higher on this composite than did boys (b = .40, p = .0005). There was also a marginal tendency for European American children to show more effortful control than African American children (b = .23, p = .0555). The main effects of maternal sensitivity and maternal education detected in this model called for further qualification as both variables were also involved in a three-way interaction with high distress in the arms restraint.

The pick-a-point method was used to probe this interaction in two different ways by treating alternatively measures of high distress and maternal sensitivity as the independent variables. First, with high distress as the independent variable, predictions of effortful control were compared at nine different combinations of maternal sensitivity (i.e., one SD below the mean, at the mean, and one SD above the mean) and maternal education (i.e., one SD below the mean, at the mean, and one SD above the mean). The corresponding analyses indicated that none of these conditions resulted in a significant change in the slope of the function relating high distress in the arms restraint procedure and effortful control.

Next, the effect of maternal sensitivity on effortful control was tested at nine different combinations of child distress (i.e., one SD below the mean, at the mean, and one SD above the mean) and maternal education (i.e., one SD below the mean, at the mean, and one SD above the mean). Three of these conditions produced significant changes in the slope of the function relating maternal sensitivity and effortful control. As show in Figure 7, with maternal education below the mean, a positive effect of maternal

sensitivity on effortful control was observed when high distress scores were below the mean (b = .35, p = .0469). With maternal education at the mean, a positive effect was observed when distress scores were at the mean (b = .19, p = .0142). And finally, when maternal education was above the mean, increases in maternal sensitivity resulted in significant gains in effortful control even for children who spent large proportions of time in high distress (b = .32, p = .0265). It is worth observing that these last analyses, although a different measure of child distress was used, replicated the effects noted in Model 3, namely, that at increased levels of maternal education the protective effects of maternal sensitivity in the acquisition of effortful control become more salient and this protective effect tends to extend to the highest levels of observer-rated child distress.

## 3.3.3 Post-Hoc Regression Analyses

Model 5 - Three-Way Interaction among IBQ-R Distress to Limitation, High Distress in Arms Restraint, and Maternal Sensitivity

Models 3 and 4 suggested that the protective effect of maternal sensitivity on the acquisition of effortful control increased with maternal education. Together, these two models also show that this effect holds true whether child negativity is measured via maternal reports of child temperament (i.e., IBQ-R) or via more "objective" measures of this negativity in the laboratory (i.e., percentage of time in high distress while in arms restraint). Although no hypothesis was originally made in this respect, this finding raises the question: How do different degrees of convergence between these two measures affect the acquisition of effortful control and how would maternal sensitivity function to affect this relation? Also, as reported earlier, there was no significant correlation between these two measures of child negative emotionality at 6 months (r = -.009, p = .91). Thus,

to better understand the role of child negative emotionality and reactivity in the development of effortful control, it was indicated to examine further the relation between these two standard measures of child negative emotionality although this was not one of the main questions of the study.

The regression model examining the interaction effect of distress to limitation, time in high distress in the arms restraint, and maternal sensitivity on effortful control was highly significant (F(10, 127) = 5.86, p < .0001) and accounted for approximately 32% (Adjusted  $R^2 = .26$ ) of the variation observed in effortful control at 36 months (see Model 5 in Table 2). Effortful control was significantly predicted by child sex (b = .45, p < .0001), indicating that girls scored higher on effortful control than boys did. Maternal education was also positively predictive of effortful control (b = .08, p = .0009). Results also revealed a significant three-way interaction among distress to limitation, high distress while in arms restraint, and maternal sensitivity.

The pick-a-point method was utilized to determine the nature of this interaction. To better understand the complex relationship among these factors, it was of interest to probe this interaction in three different ways. First, distress to limitation was treated as the independent variable, and the values of the slopes representing the relation between distress to limitation and effortful control were tested at nine different combinations of the proportion of time in high distress in the arms restraint (i.e., one SD below the mean, at the mean, and one SD above the mean), and maternal sensitivity (i.e., one SD below the mean, at the mean, and one SD above the mean). There was no significant regression slope at any of these combinations.

Second, the proportion of time in high distress was treated as the independent variable, and the values of the slopes representing its relation to effortful control were tested at nine different combinations of distress to limitation (i.e., one SD below the mean, at the mean, and one SD above the mean), and maternal sensitivity (i.e., one SD below the mean, at the mean, and one SD above the mean). As shown in Figure 8, the results revealed that the slope defining the relation between the proportion of time in high distress while restrained and effortful control was significantly different from zero when distress to limitation was above the mean, and maternal sensitivity was below average (b = .0048, p = .0198). It would be prudent not to interpret this specific effect because this regression line represented only a few data points in this sample.

Lastly, maternal sensitivity was treated as the independent variable. Its relation to effortful control was examined under nine conditions defined by three levels of distress to limitation (i.e., one SD below the mean, at the mean, and SD above the mean), and three levels of the measure of high distress in the arms restraint procedure (i.e., one SD below the mean, at the mean, and one SD above the mean). As shown in Figure 9, increases in maternal sensitivity resulted in significant gains in effortful control when mother-reported distress to limitation was above the mean, and the proportion of time in high distress was below average (b = .38, p = .0174). Thus, maternal sensitivity had a positive effect on effortful control for children who received high maternal ratings of distress to limitation and spent less than average proportion of time in high distress during the arms restraint procedure.

# 3.4 Latent Class Analyses

Two series of latent class analysis models were conducted, with one using the IBQ-R distress to limitation scores as the measure of the construct of negative emotionality, and the other using the proportion of time in high distress in the arms restraint procedure as the measure of child negative emotionality. In the latter case, due to the highly skewed distribution of the measure from the arms restraint task (see Figure 2), the latent class solutions were mainly driven by this variable alone, which may explain why the class classifications did not relate significantly to the individual differences in effortful control at 36 months. Thus, only the first series of models were reported here.

Table 3 presented the model fit indices of the series of LCA models from 1-class solution to 4-class solution, which indicated that the 2-class solution provided the best overall fit to the data and was thus retained as the final solution. Figure 10 presents the means of the z-scores of the input variables, the demographic variables and the outcome of the two classes from the 2-class LCA solution.

T-tests results, presented in Table 4, showed that the mean of the IBQ-R distress to limitation scores of class 1 was significantly lower than that of class 2 (t = -4.07(130), p < .0001). The mean of maternal sensitivity of class 1 was significantly higher than that of class 2 (t = 14.30(130), p < .0001). And, there was also a trend that the mean of sustained attention of class 1 was higher than that of class 2 (t = 1.97(130), p = .0507). The two classes did not differ in the percentage of time in high distress in arms restraint, child race/ethnicity, or child sex. However, the mean of maternal education of class 1 was significantly higher than that of class 2 (t = 4.13(129), p < .0001). Further, when relating the two-class classification to the outcome variable, results revealed a trend that children in class 1 scored better on effortful control than did children in class 2 (t = 1.92 (125), p

= .0569). It is worth noting that in the subsequent MLR analysis, after controlling for the three demographic variables, there was no significant effect of class classification on the effortful control composite score at 36 months (b = -.17, p = .20), although the overall model was significant (F(4, 121) = 8.48, p < .0001), and all of the three demographic variables had a significant main effect on the outcome.

#### VI. DISCUSSION

The goal of the present study was to understand how the child's early temperamental predispositions, the caregiving environment, and the interactions among these factors shape the developmental pathways to effortful control in early childhood. Given the complexity of the phenomenon, the data analysis plan specified two complementary approaches to examine this question. The variable-oriented analyses examined the main and interactive effects of individual and environmental variables on the development of effortful control, while the person-oriented analyses aimed to identify differential patterns of similarities among the subjects that may be predictive of differences in effortful control at 36 months of age. These two approaches complemented each other well and provided a coherent picture of how effortful control develops. The findings obtained by these analyses are discussed in the sections that follow.

### 4.1 Effortful Control

Of the five measures of the construct of effortful control used in this study, only three, the CBQ effortful control factor, the behavioral measures derived from the delay of gratification task, and the unicorn-dragon task converged to form a coherent effortful control composite. This composite was used in all of the analyses. The two measures that did not converge on this factor were the day-night and the grass-snow tasks. Although these tasks have been used in the past to assess effortful control (e.g., Carlson & Moses, 2001), some studies reported that they correlated poorly with other measures of the same

construct (e.g., Lengua et al., 2007). In the present case, the grass-snow task may have been problematic because our three-year-olds had had probably no opportunity to see snow on the ground in the greater Durham area in North Carolina where they resided. Similarly, it is possible that performances on the day-night task were influenced by differences in knowledge base, as this task requires the forming of an association, day and night, that some children may not have made yet. By contrast, at there years of age, moral reasoning is sufficiently developed to support an understanding of "good" and "bad" (Kohlberg, 1976), or "nice" versus "mean" as required in the unicorn-dragon task. Moreover, characters such as these are routinely featured in cartoon TV shows and children books.

The three demographic variables considered in this study, race/ethnicity, child sex, and maternal education were all related to effortful control in bivariate analyses. Consistent with the results of a meta-analysis conducted by Else-Quest and colleagues (2006), girls in the present sample scored higher on the effortful control composite than did boys. Also, European American children had higher scores on this composite than did African American children. However, as in many community samples, race/ethnicity and socioeconomic status were somewhat confounded in this sample, such that this difference may reflect, at least in part, race-based differences in socioeconomic disadvantage. Finally, higher levels of maternal education were associated with higher scores on the measures of effortful control at 36 months of age.

With different sets of predictors entered in the successive equations specified for models 1 through 5, race/ethnicity emerged only inconsistently as a predictor of effortful control and for this reason was not probed further in higher interactions. By contrast,

child sex and maternal education emerged in the regression analyses as important moderators of the relation between child negativity and effortful control. Though the analyses supported the hypothesis that child sustained attention and maternal sensitivity both moderated this relation, the contribution of these demographic variables in three-way interactions showed that the pathways to effortful control I predicted may be subjected to different constraints for boys and girls, and for children with mothers of different levels of education (Table 2).

### 4.2 Negative Emotionality and Sustained Attention

As hypothesized, the regression analyses showed that sustained attention at 12 months moderated the effects of infantile distress on effortful control at 36 months. I did not anticipate, however, that this interaction would be qualified further by three-way interactions implicating the sex of the child and maternal education.

With child sex as an additional moderator, high distress in arms restraint was positively associated with effortful control but only for girls whose sustained attention was at or below average. This effect of infant negativity on effortful control was the exact opposite of what I had predicted. Moreover, I had predicted that higher, not average levels of attention would moderate this relation. The first question to ask at this juncture is by what process ratings of infant negativity could predict a better rather than a lower capacity for effortful control at 36 months. An indirect but illuminating finding in this regard is that during infancy a high amplitude of heart rate variability at rest (measured either through vagal tone or rhythmic sinus arrhythmia (RSA)) is a positive correlate of both child negative and positive affective responses to a variety of environmental stimuli (e.g., Porges, Doussard-Roosevelt, Portales, & Suess, 1994; Porter, Porges, & Marshal,

1988; Fox, 1989; Stifter, Fox, & Porges, 1989; Porges, Arnold, & Forbes, 1973; Richards, 1985). As Beauchaine (2001) noted, it is only when measured *later* during toddlerhood and childhood that heart rate variability becomes a negative predictor of childhood problems (e.g., Porges et al., 1994; Porter et al., 1988). In this light, it may be more accurate to conceive of child emotional distress in the arms restraint, not as "infant negativity", but as a healthy response to noxious stimulation. Indeed, Stifter and her colleagues reported that infant distress observed in this procedure did not directly predict maladaptive outcomes (i.e., toddler noncompliance, Stifter et al., 1999). The same developmental logic explains the seeming discrepancy between my results and those of Kochanska and Knaack (2003) that showed a positive relation between negative emotionality in toddlerhood and subsequent problems of adaptation.

The second question raised by the sex-specificity of this moderation pathway is why this specificity was observed only under conditions of bw to moderate sustained attention at 12 months. First, it is important to remember that unlike Kochanska et al. (2000), for example, who measured sustained attention during solitary child play with toys, the DCHD study derived this measure from an interactive context in which, in addition to toy play, naturally occurring exchanges were taking place between mothers and their child. In this context, girls showed lower levels of sustained attention than did boys. Although social exchanges were not coded, there are grounds to believe that this difference reflects a higher frequency of mother-child interactions in same-sex than in mixed sex dyads. In support of this inference, Lovas (2005) showed that toddlers' responsiveness to parents as well as parental involvement with the child was the highest in mother-daughter dyads as compared to father-daughter, mother-son, and father-son

dyads. A second viewing of the videotapes revealed that the children who received the highest scores on this measure appeared almost nesmerized by the toys and seemed oblivious to maternal bids for interaction. While this behavior may, in its extreme, constitute autistic-like behaviors, Lovas' (2005) findings suggest that their occurrence in social interactions would be more problematic for girls than for boys as they would diverge more from the norm for girls than they would for boys. In the light of this evidence and the role of infant negativity as discussed above, the results obtained in Model 1 would suggest that young girls who at 36 months showed higher levels of effortful control were those who were capable of mounting a healthy emotional response as infants and who engaged in sex-normative interactions with their mother as they entered toddlerhood.

With the three-way interaction involving the sex of the child removed from the regression equation, Model 2 not only showed a main effect of maternal education, but it also showed that maternal education sets boundary conditions on the moderating effect that sustained attention has on the relation between child distress and effortful control. Maternal education is often used in the DCHD study as a proxy for socioeconomic status. This variable was used in the same way in the present research as higher levels of formal education have been systematically linked in prior research to higher per capita income in both married-parents and single-parent families (e.g., Brody, Flor, & Neubaum, 1998).

My initial hypothesis was that sustained attention would moderate the relation observed between infant distress and effortful control in childhood. The present results indicate that not only the sex of the child, but also maternal education can constrain this process. Although studies often do not find gender differences during infancy using both

parental reports and home observations of temperament (e.g., Chess & Thomas, 1984; Lemery, Goldsmith, Klinnert, & Mrazek, 1999; Rothbart, 1986), there may exist differences in parental tolerance of distress displayed by boys and girls. It is possible to surmise that "healthy" child distress predicts positive gains in effortful control for girls who otherwise interact well with their mothers, in part because this distress is regarded as normative by mothers of baby girls. By a similar reasoning, Model 2 may be interpreted as suggesting that, irrespective of sex, better educated mothers with infants who interact well with them (i.e., moderate levels of sustained attention to toys) tend to view infant distress in the same way.

This interpretation rests on the assumption that maternal perceptions of infant distress as normative have a "permissive" effect on the positive link observed between infantile distress and later capacities for effortful control. This assumption finds support in a vast literature showing that beliefs about parenting and knowledge of normative child development are important determinants of child outcomes. In the first case, research shows that beliefs regarding parental roles promote and reinforce the use of specific parental behaviors that may or may not be optimal for the child (Luster, Rhoades, & Haas, 1989; Sigel & McGillicuddy-De Lisi, 2002). The DCHD study, for example, shows that mothers with higher levels of education are less likely to emphasize discipline and control than mothers with less education, or to be concerned that providing too much attention may spoil the child. Parental beliefs on these issues may either promote or discourage responsiveness to fussiness and a propensity to comfort a distressed child (Smyke, Boris, & Alexander, 2002; Solomon & Martin, 1993). In the present study, mothers with higher levels of formal education indeed displayed more sensitive parenting

behaviors in mother-child interactions. Thus, parenting behaviors informed by a faulty set of beliefs may be conducive or detrimental to the acquisition of effortful control because the organization of this regulative capacity is highly dependent upon parental scaffold, especially in infancy, when the maintenance of a healthy homeostatic state rests largely upon the receipt of adequate attention and care from the parent (Hofer, 1994; Tronick, 1989). Given that educated mothers tend to use more effective strategies to cope with stressors in their daily life, it is quite likely that this quality could also buffer parental behaviors against the taxing effect of raising a more reactive child (Crnic & Greenberg, 1987; Seligman, 1991).

General knowledge of what is normative and what is not at different stages of child development is another avenue by which maternal education can have an impact on child development. Not surprisingly, research shows that mothers with higher levels of education are generally more informed in this regard (Reich, 2005). In a study of maternal knowledge of developmental milestones up to age seven, Zepeda and Espinosa (1988) found effects of maternal education in the expected direction that held for several ethnic groups including Hispanic, Black, and White mothers. It is almost a truism to state that this knowledge should make mothers more likely to be both more tolerant of child distress and more inclined to comfort a child in distress than would its absence. In this regard, the present results showed that the facilitative effects of infant distress in the arms restraint task on the acquisition of effortful control were not observed at low levels of maternal education but increased with successive levels above the sample mean.

In summary, these analyses reported in this section supported my prediction that the relation between infant distress and effortful control would be moderated by sustained

attention. Importantly, they also revealed that this moderation process takes place contingently upon the contextual limits imposed by the sex of the child and the relative education of the mother.

## 4.3 Negative Emotionality and Maternal Sensitivity

The next two sets of analyses (Models 3 and 4) were conducted to test the hypothesis that maternal sensitivity at 6 months of child age moderates the negative effects of infant negativity on effortful control at 36 months. This hypothesis was tested using two different measures of infant negativity—distress to limitation (DTL) assessed through maternal reports via the Infant Behavior Questionnaire, and high distress in response to the arms restraint procedure. As shown in bivariate correlations these two measures were literally orthogonal. This is somewhat surprising in light of the fact that the arms restraint procedure was conceived as an experimental situation presumably capable of eliciting infant reactions similar to those captured by the DTL dimension of the IBQ questionnaire (LAB TAB, Goldsmith and Rothbart, 1996). This correspondence was not observed in the present research.

In the first model (Model 3) the moderating role of maternal sensitivity on the relation between infant negativity and effortful control was tested using the IBQ distress to limitation scale. By itself, this variable was found to predict, but only marginally, lower scores on effortful control. As expected, maternal sensitivity predicted positive gains in effortful control. This finding resonates well with a vast body of research showing consistently that sensitive parenting promotes optimal child adaptation. However, this model did not reveal, as predicted, that maternal sensitivity *generally* attenuates the effect of child distress on effortful control. Instead, it showed that although

present, this moderation was conditioned by maternal education, just as earlier when child sustained attention was posed as a moderator. Probing this three-way interaction showed that the moderating influence of maternal sensitivity on the relation between child distress and effortful control changes appreciably at different levels of maternal education.

It was theoretically meaningful to pose child distress and maternal sensitivity alternately as predictor or moderating variables in the analyses conducted to condition the above three-way interaction. First with distress to limitation as the predictor, the analysis showed that high scores on this variable predict lower effortful control scores only when mothers do not exceed an average level of sensitivity and when they have received less than an average level of education. With maternal sensitivity predicting effortful control, successive increments in maternal education were shown to widen the range of child distress over which protective effects of maternal sensitivity were observed. This is a meaningful contribution that adds to the few extant studies that examined and found interaction effects between sensitive parenting and negative emotionality on adaptive child outcomes. It is also worth noting that the moderation effects observed in these analyses were always contingent upon maternal differences in educational status.

A positive main effect of maternal sensitivity on effortful control was observed again when child negativity was assessed as the percentage of time in high distress while in arms restraint (Model 4). Interestingly, when this interaction was probed with arms restraint distress as the predictor variable, no combination of levels of maternal sensitivity and education could be identified that significantly affected the relation between child distress and effortful control. By contrast, maternal sensitivity predicted

positive gains in effortful control under three different combinations of child distress and maternal education. When maternal education was low these gains were observed only when child distress was also low. It is remarkable that with higher levels of maternal education, maternal sensitivity continued to predict similar gains even when child distress was rated in the highest range.

Are the strong effects of maternal education on the processes examined in the present study surprising? Is it unusual for maternal sensitivity to buffer "contingently"? This is probably not so, given the nature of the child outcome that was predicted in these analyses. Indeed, the growing interest in effortful control among developmental psychologists stems largely from the fact that it supports a host of adaptive behaviors such as emotion regulation, social integration to the peer group and the academic setting, and executive functions — adaptive capacities that are collectively key to achieve social and economic success, social control, and prestige (see Introduction). Not so surprisingly, the present investigation suggests that the relative degree of personal social achievement parents bring to their interaction with their child, creates, as a physicist would say, "a force field within which maternal sensitivity acquires mass (i.e., protective potential)." It will remain for future research to determine how specific this effect is to this or similar outcomes, and by what exact process it is obtained.

## 4.4 Post-Hoc Regression Analyses

In the preceding analyses we have seen that only the IBQ measure of child distress (Model 3) functioned as a predictor of individual differences in effortful control, and that no conditions were identified under which distress in the arms restraint predicted the same differences (Model 4). This could appear to imply that one measure has predictive

validity, while the other does not. But this would be only partially true because when the regression analyses included only the child factors (Models 1 and 2), high distress in the arms restraint was clearly shown to predict positive gains in effortful control. As suggested earlier, if the establishment of this positive relation requires a "permissive" context, it would not be surprising to observe, with the inclusion of maternal sensitivity in the equation, that this permissive context is all that we can see. It was thus of interest, in post-hoc analyses, to examine how the relation of differential scores on these two measures to effortful control may be moderated by maternal sensitivity.

With probing, the resulting three-way interaction revealed a positive effect of maternal sensitivity on effortful control for children with high maternal ratings of distress to limitation and with a low percentage of time observed in high distress in the laboratory. Accordingly, the group that satisfied this condition was composed of children who, while perceived by their mother as very prone to angered distress, were the least responsive to the arms restraint procedure. This pattern is reminiscent of the lack of responsiveness to acute stress and the oppositional-defiant behaviors seen in childhood among children with externalizing problems (e.g., Boyce, Quas, Alkon, Smider, Essex, & Kupfer, 2001; van Goozen, Matthys, Cohen-Kettenis, Gispen-de Wied, Wiegant, & Engeland, 1998; see Bauer, Quas, & Boyce, 2002 for a review). That maternal sensitivity had detectable positive effect, specifically for this group, is further indication of the fundamental importance of this parental quality to child development. It is quite possible that maternal sensitivity could magnify the positive effects of patterns that, by themselves, normally facilitate the acquisition of effortful control. Because these processes involve higher order interactions among predictors they often remain elusive in regression analyses conducted

with data sets the size of ours. The same constraint prevented me from examining the interplay between these two measures of child distress, maternal sensitivity, and maternal education.

## 4.5 Latent Class Analyses

While in regression analyses interaction effects were examined based on a priori hypotheses, LCA was conducted to detect similarity among subjects using a set of predefined variables. Two classes were detected and revealed profiles that were meaningfully and differentially related to the capacity of effortful control at 36 months of age. Children with lower levels of mother-reported proneness to distress, middle range of sustained attention, and experiencing sensitive parenting scored significantly higher on the composite of effortful control than others with high levels of DTL, low levels of sustained attention and the absence of sensitive rearing environment. It is rather remarkable that completely independent from the regression analyses, LCA generated these two profiles that fit quite nicely with the interaction effects from the multiple regression models.

## 4.6 Limitations and Future Directions

Although this study generated many novel and meaningful findings that contribute to understanding the development of effortful control in early childhood, it did have its limitations. It was useful to examine these limitations starting from measurement issues. There was nonrandom missing data in both the arms restraint task and inhibitory control tasks. In the arms restraint task at 6 months of child age, data could be missing due to a couple of systematic reasons, such as the task was never administered because the child

got overly distressed from the still-face paradigm that preceded this task, or the task was terminated quickly because the child got extremely distressed. In the inhibitory control tasks, children had to successfully pass the practice trials to proceed to test trials. It would be reasonable to assume that children who did not pass the practice trials had lower levels of effortful control than those who did. However, other factors could also explain why data was missing in the inhibitory control tasks, such as a general lack of cooperation due to fussy moods or an absence of interest on the day of the laboratory visit, and/or a lack of knowledge required to pass the practice trials, etc. The nonrandom missingness of the data resulted in the second limitation of the study in terms of the feasible analytical strategies, because missing data imputation was not appropriate. Structural equation modeling (SEM) would have been a more advanced analytical strategy that could take into account measurement error of the observed indicators, had the sample size been large enough for SEM.

Furthermore, the role of sustained attention in the development of effortful control would have been better clarified, if multiple attention measures assessed in different contexts had been available. This work suggests that future research should use measures of social engagement, attentional flexibility, and attentional focusing assessed in both social and solitary contexts to elucidate the relations between attentional processes and the development of effortful control in early childhood.

Also, the findings that distress to limitation on the IBQ-R and the percentage of time in high distress in the arms restraint procedure at 6 months of child age had effects of opposite directions on effortful control at 36 months of age was rather novel and intriguing. Negative emotionality and reactivity have long been a focus of developmental

research, thus it is critical to clearly understand the validity of the established measures, including both maternal reports and laboratory tasks. Employing psychobiological measures, such as cortisolic response, heart rate, RSA, and skin conductance, could potentially shed new light on the validity of parent-reported ratings and observational assessment of negative emotionality and reactivity.

Moreover, this study was an attempt at using multiple measures to examine these research questions. The subjective measures were comprehensive, but may be confounded with reporter biases, while the objective measures obtained in controlled laboratory contexts may assess only some but not all aspects/dimensions of the same construct. This work highlights the importance of operationalization in human research, and specifically, the benefits of using multiple measures of the core constructs, of evaluating them in different contexts and via different informants, given the constraints that this process naturally imposes on our understanding of complex phenomena.

Lastly, perhaps one of the most provocative finding in this research was that the capacity of maternal sensitivity to protect against a negative outcome changed with varying levels of maternal education. It will be important to examine in future research what it is exactly about maternal education that facilitates this effect. Is the fact that maternal education is associated with more consistency in sensitive parenting? After all high levels of maternal sensitivity displayed in free play in the laboratory do not necessarily imply that the same levels are maintained at home under the daily stresses of life, and especially at times when the child is in distress. As noted earlier, better educated mothers employ coping strategies that may enable them to be more consistently sensitive in their interactions with their child. In Tronick's (1989) term these mother might be less

prone to commit "interactive errors" and/or more capable of repairing them quickly. Or is it via a better knowledge of normative child development, such that better educated mothers, as they fill the IBQ are telling us that their child is "a very emotional child", while less informed mothers are telling us, instead, that their child "is a cry baby"? This work suggests that discovering the underlying mechanism by which maternal education exerts influence on the development of self-regulatory capacities will contribute to advancing our understanding of the multiple developmental pathways to effortful control in early childhood.

**Table 1. Descriptive Statistics and Bivariate Correlations** 

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Demograhics														
1 Child race/ethnicity														
2 Child sex	-0.08													
3 Maternal Education at 6 months	0.34 ***	-0.03												
6 months														
4 Distress to limitation on IBQ	-0.23 **	0.03	-0.18 *											
5 Percent of time crying in arms restraint	0.03	0.04	-0.21 *	-0.01										
6 Maternal sensitivity during free play	0.31 ***	-0.06	0.51 ***	-0.23 **	-0.09	_								
12 months														
7 Sustained attention during free play	0.07	-0.17 *	0.07	-0.07	0.06	0.08								
36 months														
8 Effortful control composite in analysis	0.24 ***	0.30 ***	0.37 ***	-0.15 †	0.05	0.27 ***	0.10							
9 Effortful control factor on CBQ	0.02	0.27 ***	0.11	-0.05	-0.01	0.10	0.09	0.64 ***						
10 Peeking composite in delay of gratification	0.40 ***	0.12	0.34 ***	-0.20 *	0.15 †	0.31 ***	0.13	0.68 ***	0.13					
11 Delay composite in delay of gratification	0.26 ***	0.22 **	0.36 ***	-0.15 †	-0.02	0.24 **	0.09	0.78 ***	0.28 ***	0.42 ***				
12 Unicorn-dragon correct answer proportion	0.19 *	0.04	0.25 **	0.00	-0.02	0.14	-0.09	0.61 ***	0.07	0.21 *	0.29 ***			
13 Day-night correct answer proportion	-0.05	-0.06	-0.11	0.10	0.07	-0.01	0.15	0.04	0.10	-0.06	-0.01	0.09		
14 Grass-snow correct answer proportion	0.06	-0.02	-0.01	0.05	-0.02	0.03	0.08	0.07	0.04	0.04	-0.01	0.09	0.13	
N	20.6	206	150	150	1.0	100	150	100	1.07	1.60	164	1.15	1.10	120
N	206	206	179	179	162	175	153	180	167	163	164	145	142	128
Mean	0.43	0.49	14.40	3.56	29.81	3.29	2.99	-0.01	5.27	0.00	0.00	51.57	51.10	45.00
SD	0.50	0.50	2.69	0.88	38.92	0.81	0.88	0.73	0.56	0.91	0.87	12.22	23.33	27.02
Minimum	0.00	0.00	8.00	1.44	0.00	1.00	1.00	-2.06	3.38	-0.59	-1.77	20.00	0.00	0.00
<u> Maximum</u>	1.00	1.00	20.00	5.94	100.00	5.00	5.00	2.01	6.54	2.32	0.89	100.00	100.00	100.00

Note.  $\dagger p < .10$ .  $\ast p < .05$ .  $\ast \ast p < .01$ .  $\ast \ast \ast p < .001$ . Child race/ethnicity: 0 = African American, 1 = European American; Child sex: 0 = Male, 1 = Female.

**Table 2. Results from Five Multiple Linear Regression Models** 

Dependent Variable - Effortful Control Composite at 36 Months											
	M	odel 1	M	odel 2	M	odel 3		M	odel 4	N	Iodel 5
Predictors	В	SE	В	SE	В	SE		В	SE	В	SE
Child race/ethnicity	0.202	0.154	0.064	0.160	0.222	0.111 *	0	.234	0.121 †	0.188	
Child sex	0.400	0.153 *	0.238	0.158	0.488	0.105 **	** 0	.398	0.111 ***	0.454	0.112 ***
Maternal Education	0.039	0.032	0.081	0.033 *	0.074	0.023 **	0	.088	0.025 ***	0.085	0.025 ***
Distress to limitation (DTL)					-0.121	0.066 †				-0.037	0.068
High distress in arms restraint (AR)	0.000	0.002	0.004	0.001 *			0	.001	0.002	0.002	0.001
Sustained attention	0.073	0.087	-0.037	0.070							
Maternal sensitivity					0.159	0.077 *	0	.187	0.087 *	0.125	0.083
AR X Attention	0.002	0.002	-0.002	0.002							
AR X Sensitivity							0	.000	0.002	-0.001	0.002
AR X Sex	0.006	0.003 *									
AR X Education			0.000	0.001			0	.000	0.001		
Attention X Sex	-0.076	0.130									
Attention X Education			0.019	0.027							
DTL X Sensitivity					-0.020	0.082				0.076	0.084
DTL X Education					0.046	0.027 †					
DTL X Crying										-0.001	0.002
Sensitivity X Education					0.025	0.023	-0	0.004	0.029		
Race X Sex	0.086	0.219	0.254	0.228							
Race X Education	0.067	0.049	0.052	0.048							
AR X Attention X Sex	-0.009	0.003 **									
AR X Attention X Education			-0.002	0.001 **							
DTL X Sensitivity X Education					0.081	0.027 **					
AR X Sensitivity X Education							0	.001	0.001 *		
DTL X AR X Sensitivity									_	-0.004	0.002 *
N		116		116		155			138		138
F(df)	F(104)	= 5.13 ***	F(104)	= 4.92 ***	F(145)	= 7.87 **	** F	(128)	= 6.79 ***	F(127)	= 5.86 ***
Adjusted R Sqaure		0.28		0.27		0.29			0.28		0.26

*Note.*  $\dagger p < .10$ . \*p < .05. \*\*p < .01. \*\*\*p < .001.

Child race/ethnicity: 0 = African American, 1 = European American; Child sex: 0 = Male, 1 = Female.

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Table 3. Model Fit Comparison from Latent Class Analysis

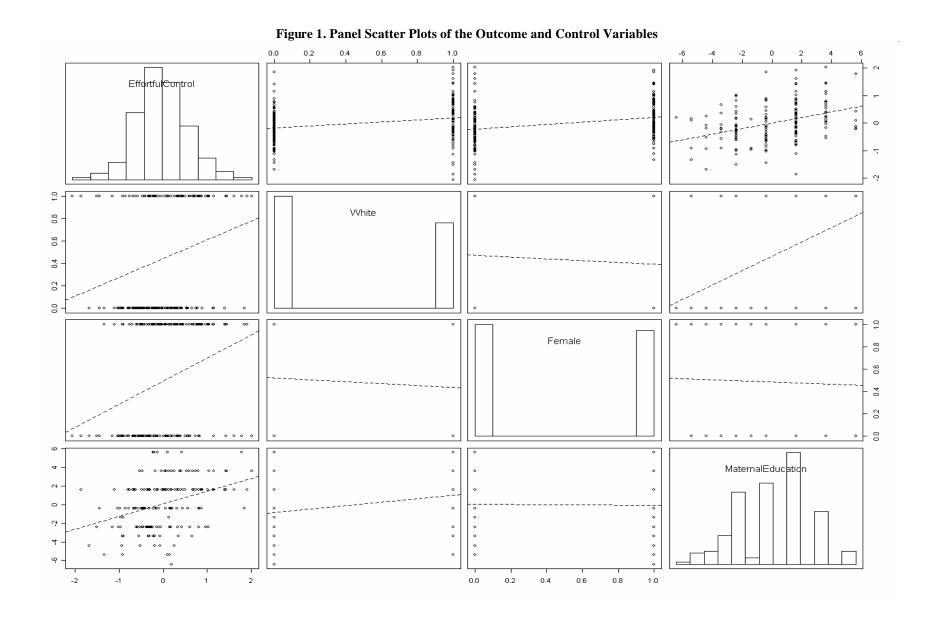
							•		
No. of Classes	Log Likelihood	BIC	AIC	Entropy	LMR-LRT	Proportion in Class 1	Proportion in Class 2	Proportion in Class 3	Proportion in Class 4
1	-510.37	1050.05	1032.75	_	_	100%			
2	-502.32	1053.46	1024.63	0.63	0.01	<b>74.24</b> %	25.76%		_
3	-498.26	1064.88	1024.52	0.63	0.20	26.52%	52.27%	21.21%	_
4	-494.70	1077.29	1025.40	0.71	0.49	25.00%	21.97%	6.06%	46.97%

*Note*. Model fit indices from the final LCA model was bolded.

**Table 4. T-Tests from Latent Class Analysis** 

Variable	Mean of Class 1	Mean of Class 2	t value	DF	p value
Distress to limitation of IBQ-R at 6 months *	3.37	4.09	-4.07	130	<.0001
Sustained attention at 12 months *	3.11	2.76	1.97	130	0.0507
Maternal sensitivity at 6 months *	3.63	2.19	14.30	130	<.0001
Percentage of time in high distress in arms restraint at 6 months	27.83	36.32	-1.01	117	0.3127
Child race	0.47	0.35	1.18	130	0.2417
Child sex	0.45	0.56	-1.10	130	0.2727
Maternal Education	14.86	12.85	4.13	129	<.0001
Effortful control at 36 months	0.02	-0.24	1.92	125	0.0569

*Note*. \* indicates the variable is an input variable for the presented latent class model.



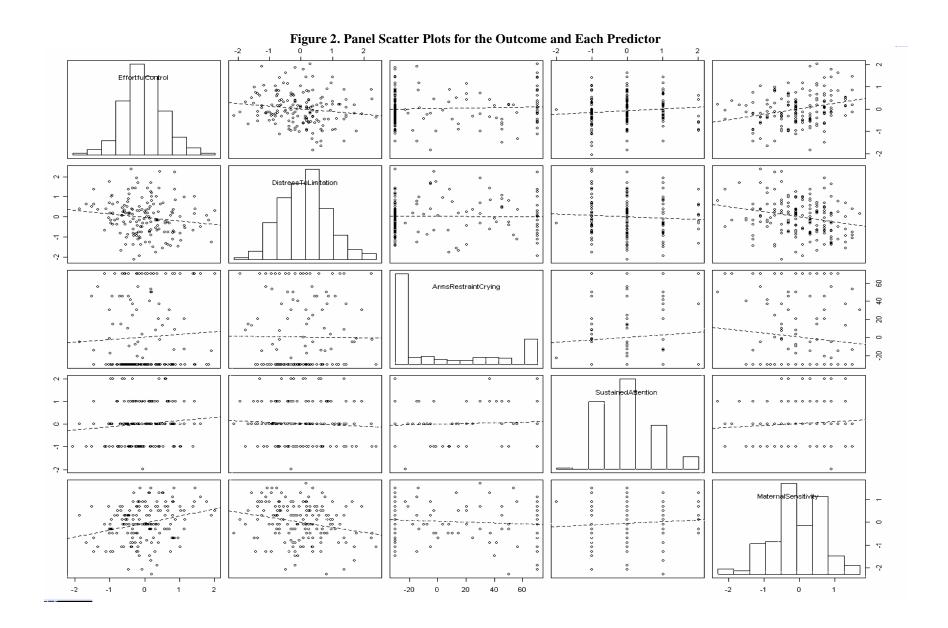


Figure 3. Sustained Attention and Child Sex Moderate the Effect of Percentage of Time in High Distress during Arms Restraint on Effortful Control

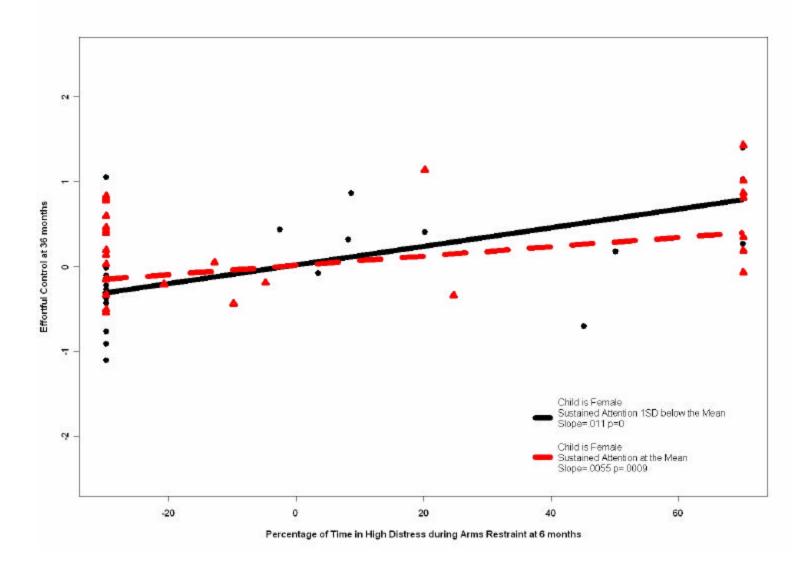


Figure 4. Sustained Attention and Maternal Education Moderate the Effect of High Distress during Arms Restraint on Effortful Control

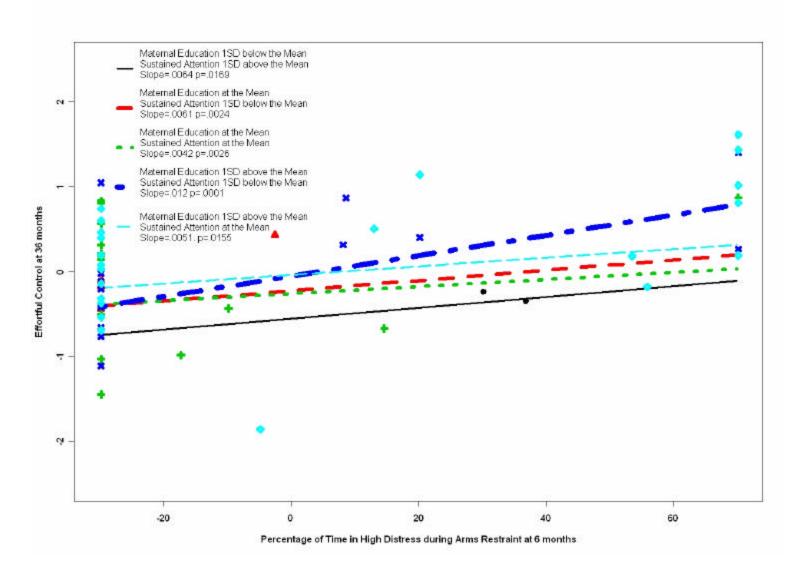


Figure 5. Maternal Sensitivity and Maternal Education Moderate the Effect of IBQ-R Distress to Limitation on Effortful Control

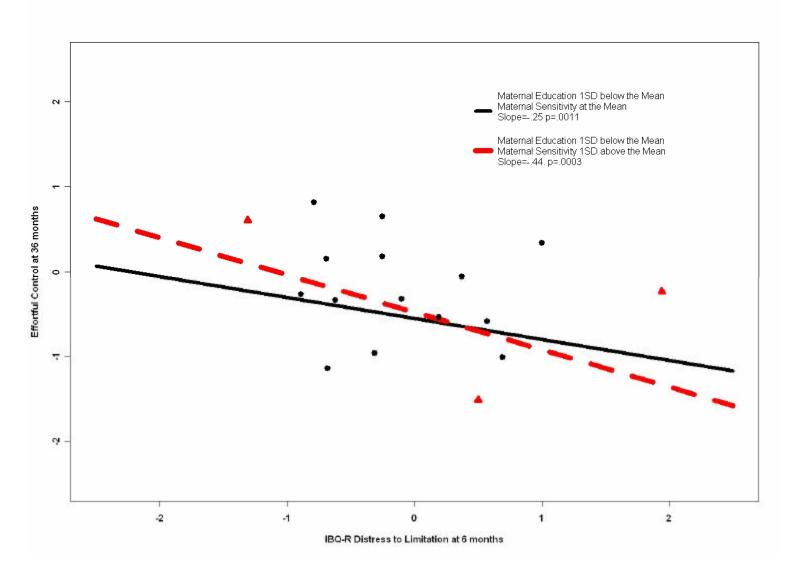


Figure 6. IBQ-R Distress to Limitation and Maternal Education Moderate the Effect of Maternal Sensitivity on Effortful Control

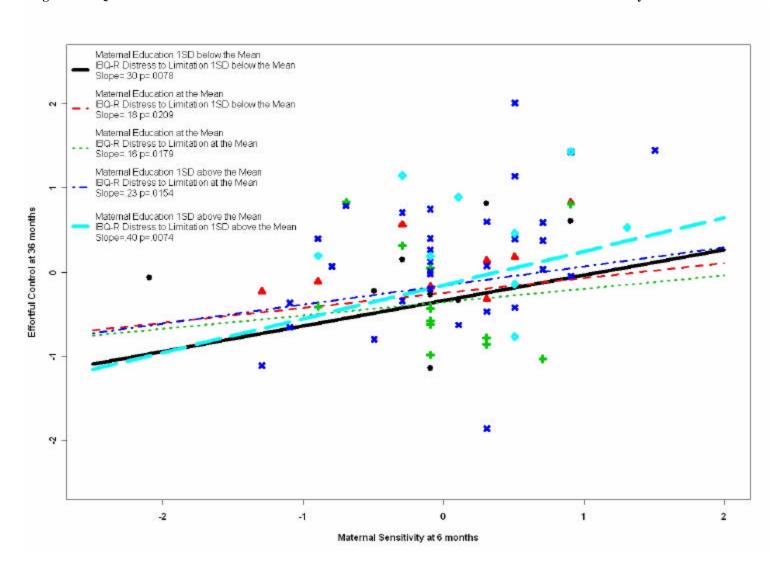


Figure 7. High Distress during Arms Restraint and Maternal Education Moderate the Effect of Maternal Sensitivity on Effortful Control

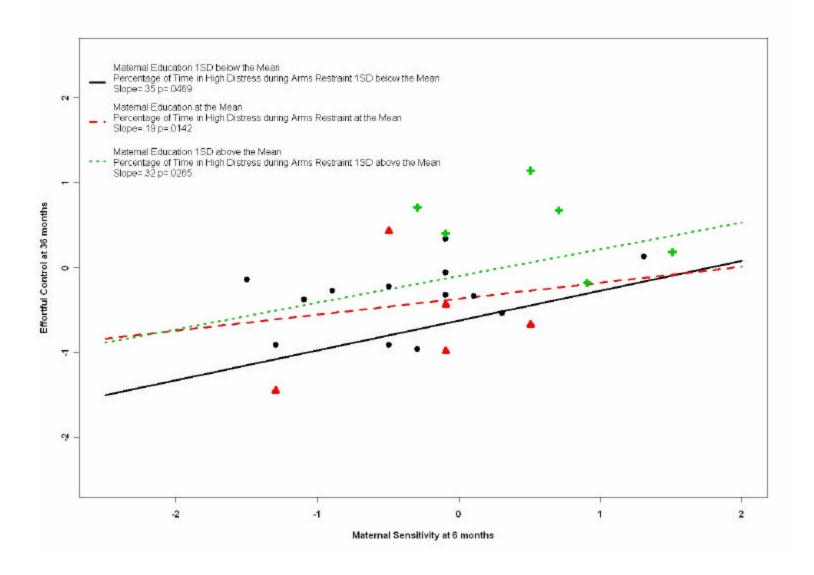


Figure 8. IBQ-R Distress to Limitation and Maternal Sensitivity Moderate the Effect of High Distress during Arms Restraint on Effortful Control

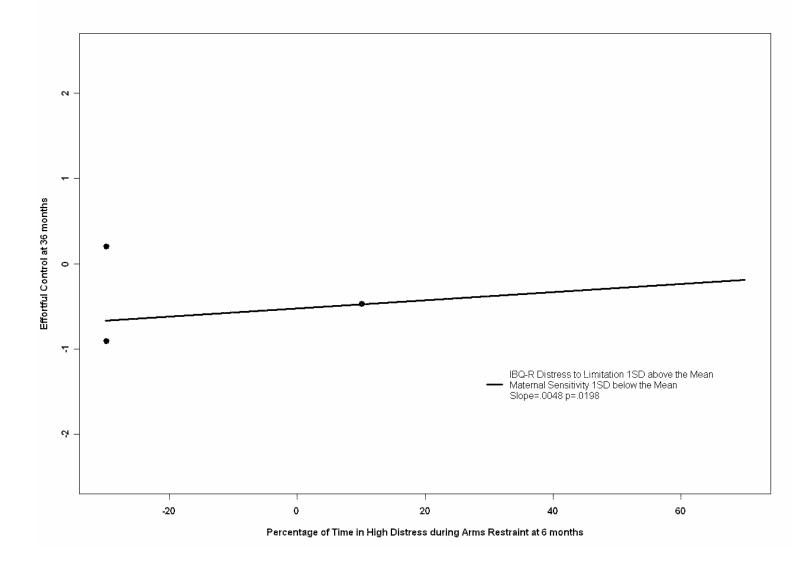


Figure 9. IBQ-R Distress to Limitation and High Distress during Arms Restraint Moderate the Effect of Maternal Sensitivity on Effortful Control

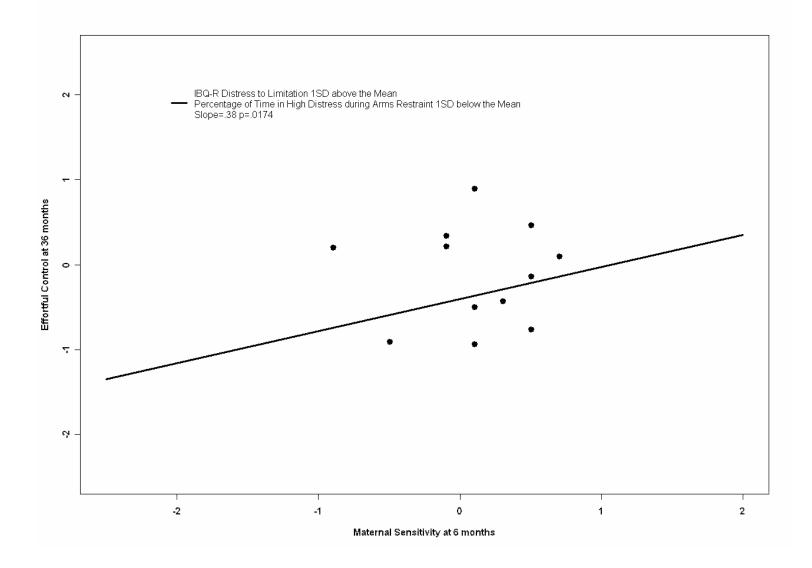
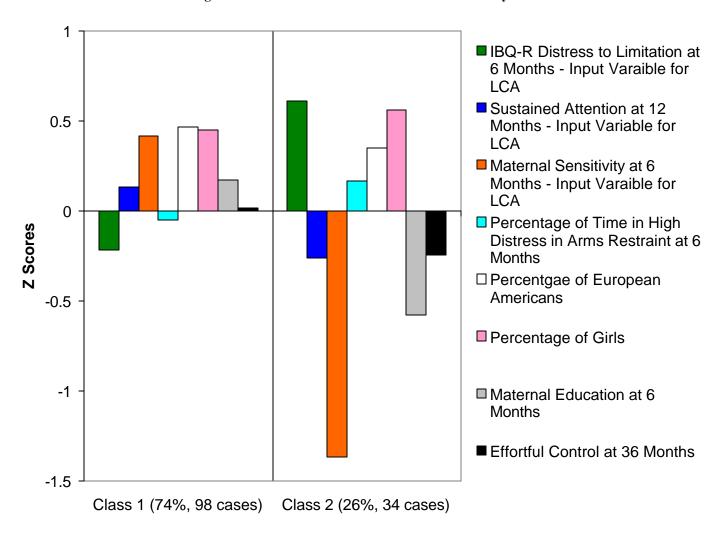


Figure 10. Two-Class Solution from Latent Class Analysis



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