THE EVOCATIVE EFFECT OF CHILDREN'S PHYSIOLOGOCIAL STRESS REACTIVITY ON INTRUSIVE PARENTING

by

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ABSTRACT

Self-regulatory processes, such as effortful control, are important facets of development for children's long term adjustment. Effortful control is known to be influenced by biological processes that enable regulatory function. Specifically, better biological regulation is associated with better effortful control. The direction of environmental effects, however, is less clear. Although theoretical perspectives support the possibility that parent-child influences are bidirectional, studies of self-regulation – both physiological regulation and effortful control – have almost exclusively focused on a parent-to-child direction of effects. Almost no research has investigated the influence of children's physiological and behavioral regulation on parenting behaviors. My thesis explored one process by which physiological regulation, indexed through measures of neuroendocrine reactivity, and behavioral regulation, indexed as effortful control, may evoke intrusive behaviors in parents. I hypothesized that greater cortisol reactivity would predict lower levels of effortful control, which would subsequently predict greater intrusive parenting. I tested my hypothesis in a sample of preschool-aged children and their parents, capitalizing on a critical period for the development of self-regulation. Results indicate that cortisol reactivity did not work through effortful control to predict parent intrusiveness. However, effortful control did moderate the association between child cortisol reactivity and parent intrusiveness. Specifically, when children were high in effortful control, greater cortisol reactivity predicted greater intrusive parenting. This work sheds light the importance of considering bidirectional effects in the development of self-regulation in early childhood.

INTRODUCTION

During early childhood, children between 2 and 3 years of age begin to develop and hone their self-regulation skills (Karoly, 1993; Rothbart, Ellis, Rueda, & Posner, 2003) which enable them to control emotions, handle frustration, and resist impulsive behavior. Effortful control, a process that underlies self-regulation (Posner & Rothbart, 2000), reflects the ability to focus and shift attention, as well as inhibit predominant behaviors and emotions in order to employ a subdominant response (Derryberry & Rothbart, 1988; Rothbart & Derryberry, 1981; Rothbart & Rueda, 2005). Effortful control is a particularly important facet of self-regulation in early life, as it is positively associated with a range of positive outcomes across early childhood. For example, higher effortful control in young children is linked to higher social competence (Diener & Kim, 2004), higher academic performance (Liew, McTigue, Barrois, & Hughes, 2008), greater self-efficacy and self-esteem (Tangney, Baumeister, & Boone, 2004), as well as better mental health outcomes in later life (Eisenberg et al., 2009; Tangeny et al., 2004).

To understand how individual differences in effortful control emerge, research has focused on biological mechanisms, in the form of physiological function that may serve as underpinnings of behaviors that denote effortful control (Doussard-Roosevelt, Montgomery & Porges, 2003; Skowron, Cipriano-Essel, Gatzke-Lopp, Teti, & Ammerman, 2014). One component of physiological self-regulation that has been associated with effortful control in young children is the neuroendocrine stress response following periods of challenge, indexed by levels of the hormone cortisol (Dedovic, Duchesne, Andrews, Engert, & Pruessner, 2009). Specifically, high cortisol reactivity in response to a stressor is associated with lower levels of effortful control in preschoolers (Gunnar, Tout, de Haan, Pierce, & Stanbury, 1997).

Effortful control has also been associated with facets of the early environment, most frequently as a product of quality of early caregiving. For example, greater levels of intrusive parenting (Eisenberg et al., 2005; Moilanen, Shaw, Dishion, Gardner, & Wilson, 2010; Taylor, Eisenberg, Spinrad & Widaman, 2013), thought to undermine the development of independent self-regulatory skills, predict lower effortful control in young children ages 1 to 3. Although this work reveals an important association between early parenting behaviors and the early development of effortful control, they ignore the possibility that parenting behaviors may be influenced by children's behavior. In fact, Parent-Child Interaction Theory (Bell, 1968) suggests that children elicit changes in parenting behaviors as parents try to adapt to their child's actions. Recent research supports this possibility in association with effortful control, showing that higher effortful control in children evokes positive parenting and better disciplinary practices, such as little to no scolding or yelling and consistent discipline procedures, in caregivers (Tiberio et al., 2016). Similarly, during preschool and early childhood, children high and low in observed levels of effortful control evoke positive and negative parenting behaviors, respectively (Eisenberg, Taylor, Widaman, & Spinrad, 2015).

Despite both theoretical and empirical support for a child-to-caregiver elicitation of effects, little research has investigated the full process by which physiological and behavioral markers of regulation lead to differences in parenting behaviors early in life. Understanding whether such an association is present very early in life as children, primarily socialized through parent behaviors, undergo rapid developmental changes in the ability to self-regulate during this period (Kopp, 1982). In the current study, I addressed this gap in the literature by investigating the extent to which physiological reactivity and effortful control in children predict intrusive parenting behaviors at 3 years of age.

Effortful Control as a Mechanism of Self-Regulation in Early Childhood

The ability to self-regulate emotions and behaviors plays a key role in child functioning, well-being, and mental health (Calkins & Hill, 2007). In early childhood, effortful control, a dimension of temperament (Rothbart & Bates, 2006) reflecting the ability to focus and shift attention, as well as inhibit predominant behaviors and emotions (Derryberry & Rothbart, 1988; Rothbart & Derryberry, 1981; Rothbart & Rueda, 2005) is believed to underlie self-regulatory abilities (Posner & Rothbart, 2000). Behaviors believed to illustrate effortful control in children include the ability to focus attention amidst distractions (Kochanska, Murray, & Harlan, 2000) and the ability to inhibit or activate behaviors and emotions in order to adapt to changing conditions, especially unpleasant circumstances (i.e. waiting for one's turn in a game or sitting still for long periods of time; Eisenberg, 2009). From ages 18 months to 5 years, effortful control behaviors also overlap with executive function tasks such as error detection, planning, and thoughtful consideration before instigating behaviors (Welsh, 2001).

The development of effortful control mechanisms, especially when the construct is broadly defined (e.g., as part of executive attention) are linked to structural and functional changes in neural attentional systems during the first and second years of life (Posner & Rothbart, 1998). However, it isn't until ages 3 and 4 that children begin to show sharp gains in proficiency and stability in effortful control capacities (Murphy, Eisenberg, Fabes, Shepard, & Guthrie, 1999; Rueda et al., 2004). These gains are believed to be related to maturation in the prefrontal cortex; the area of the brain involved in higher order planning, processing, and behavior modification, as well as stress-related neuroendocrine function and regulation (Diorio, Viau, & Meaney, 1993; Posner & Rothbart, 2000; Smith & Vale, 2006; Welsh, 2001). Effortful control is also associated with activity in the anterior cingulate cortex, a neural structure that aids in the regulation of autonomic functions such as heart rate and blood pressure, and also higher level functions like decision-making, impulse control, emotion regulation, reward anticipation, and conflict resolution (Casey et al., 1997; Posner, Rothbart, Sheese, & Tang, 2007). Thus, the early preschool years appear to be a critical period in the development of effortful control, as attention networks and neural structures undergo major growth and development (Tsujimoto, 2008).

While it may be tempting to conclude that age-related structural changes provide evidence for a prototypical path of development for effortful control, individual differences in effort control capacities, and their consequences, are quite distinct (Murray & Kochanska, 2002). For example, children high in effortful control often demonstrate more adaptive functioning and lower problem behaviors and, in contrast, children low in effortful control exhibit more problem behaviors. Children high in effortful control demonstrate lower intensity expressions to both positive and negative emotions (Vroman

& Durbin, 2015), are higher in behaviors denoting early conscience such as empathy, apologizing, sympathy, and guilt (Eisenberg et al.,1996; Kochanska, Murray, & Coy, 1997), and better prosocial behaviors (Diener & Kim, 2004) relative to low effortful control children. Children high in effortful control also show better academic performance upon school entry, an effect which remains consistent throughout their education (Liew et al., 2008; Valiente, Lemery-Chalfant, Swanson, & Reiser, 2008). Greater effortful control is also associated with greater self-esteem, and fewer reports of anxiety, depression, anger and hostility, and obsessive compulsive patterns in adulthood (Tangney et al., 2004). Moreover, children who are high and low in effortful control exhibit marked differences in observed behaviors and mental health outcomes (Eisenberg et al., 2009).

In contrast, poor effortful control during early childhood is linked to greater numbers of externalizing behaviors, including physical aggression and disobedience in childhood (Eisenberg et al., 2000) and increased aggressive-antisocial behavior and depression symptoms in adolescence (Wang, Chassin, Eisenberg, & Spinrad, 2015). These children are also linked to greater internalizing problems such as anxiety and fearfulness in late childhood (Henry, Caspi, Moffitt, Harrington, & Silvia, 1999) and a higher risk of depression and anxiety in adulthood (Brinkmann & Franzen, 2015).

Further, kindergarten aged children low in effortful control are more easily distracted and have greater difficulties with social and peer adjustment compared to children high in effortful control (Fettig, 2015). Additionally, young children with low levels of effortful control have a diminished understanding of morality in early childhood

(Kochanska & Kim, 2014) and lower resiliency, manifest as the inability to persevere, respond flexibly to changing circumstances, or recuperate after stressful or traumatic experiences, during middle childhood (Eisenberg et al., 2004).

In sum, there are a broad degree of individual differences in effortful control during early childhood. These differences are important to child outcomes as children low in effortful control exhibit more problems related to behavior, psychological functioning, and long term mental health outcomes. As such, it would be beneficial to investigate effortful control in preschool aged-children as this is the time when effortful control capacities are growing and behaviors are readily observable.

Physiological Underpinnings of Self-Regulation in Childhood

Apparent distinctions in behavior and long-term outcomes for children who are high and low effort control naturally give rise to questions about factors that may precipitate these types of individual differences. Though a single underlying cause is unlikely, both empirical research (Bell & Deater-Deckard, 2007) and temperament theory suggest that physiological responses often underlie the deployment of self-regulatory behaviors. In one such example, neuroendocrine mechanisms enable behavioral responses and coping in the face of physical or emotional stressors. Specifically, when a stressor is perceived, the hypothalamic–pituitary–adrenal (HPA) axis immediately releases epinephrine (adrenaline) and norepinephrine into the body; this, in turn, increases heart rate, constricts blood vessels, and slows down secondary bodily functions in order to focus physiological resources on coping with the stressor at hand (Miller &

O'Callaghan, 2002; Willner, Scheel-Krüger, Belzung, 2013). One of the end-products of this cascade of effects is the release of glucocorticoids into the body, including the hormone, cortisol, which helps to modulate HPA influences on peripheral systems including immune function, metabolism, blood pressure, and protein synthesis (Dedovic et al., 2009). In this way, cortisol is believed to influence active coping in the face of external stressors (Gunnar, 1992) by supporting active, approach-oriented problem solving strategies, which are effective strategies for resolving challenge (Carver, Scheier, & Weintraub, 1989). Importantly, cortisol levels also "feed back" to inhibit HPA function, particularly when stress levels subside following effective regulation. Free cortisol, or unbound cortisol not utilized for coping efforts before the stress response has subsided, is easily assessed and can index levels of neuroendocrine stress reactivity (Prussner et al., 1997),

Cortisol-based indices of stress typically occur in two forms: diurnal cortisol and reactive cortisol. Diurnal cortisol refers the regular daily cycle pattern of cortisol production, namely high values in the morning with peak cortisol appearing very soon after waking up and a relatively steady decline across the day with nadir levels occurring just before bed (Kirschbaum & Hellhammer, 1989). In children, the diurnal rhythm of cortisol is present in infants as early as 6 weeks of age (Larson, White, Cochran, Donzella, & Gunnar, 1998). By ages 3 to 3.5, children demonstrate more consistent diurnal cortisol patterns compared to infancy and early toddlerhood, indicating that cortisol production becomes more stable at preschool ages (Watamura, Donzella, Kertes, & Gunnar, 2004). In contrast, reactive cortisol is the degree to which levels of cortisol increase from baseline in response to a physical or emotional stressor (Engert et al., 2013). In early childhood, children between 21 and 70 months of age have demonstrated changes in cortisol levels based on daycare environments (Gunnar & Donzella, 2002); specifically, low quality daycare environments have been shown to evoke a cortisol stress response. A review of findings on cortisol reactivity suggests that, beyond the preschool atmosphere, other cortisol evoking stressors include fear and anger eliciting situations, exposure to novel stimulation, maternal separation, and peer stress (Gunnar, Talge, & Herrera, 2009). Both reviews and empirical work further suggest that the most reliable elicitor of cortisol reactivity in young children is exposure to a social stressor (Gunnar et al., 2009; Harkness, Stewart, & Wynne-Edwards, 2011), which elicits high levels of cortisol reactivity as early as age 9 months.

Although the reactive cortisol response serves an adaptive function in response to stressors, chronic secretion of cortisol can be harmful to the body (Gunnar & Donzella, 2002; McEwen, 1998; 2006). Glutocorticoids like cortisol are toxic in large quantities (Wilner et al., 2013) and findings suggest that chronic cortisol stimulation in the body can interfere with early phases of neurogenesis and neuronal survival and function in the hippocampus (Czéh et al., 2001). This phenomenon is particularly strong in situations where an individual feels unequipped to deal with a stressor. Further, high cortisol levels can cause damage to the medial and lateral prefrontal cortex and anterior cingulate cortex (Hinwood, Morandini, & Walker, 2012), thereby influencing decision-making, impulse control, and emotion regulation. Given the importance of these neural structures for effortful control, it is perhaps not surprising that cortisol and effortful control have been previously linked during childhood. Further, there is more evidence for the link between effortful control and reactive cortisol as opposed to diurnal cortisol. More specifically, greater cortisol reactivity to social stressors is associated with lower effortful control in preschoolers ages 3 to 5-years-old (Gunnar et al., 1997). Greater cortisol reactivity following an emotional stressor is also positively associated with externalizing behaviors (Essex, Klein, Eunsuk, & Kalin, 2002), which are often characterized by low levels of effortful control (Olson, Sameroff, & Kerr, 2005). Additionally, toddlers with greater reactive cortisol to social stressors tend to play less with peers, have lower levels of play complexity (Gunnar et al., 1997) and are rated as lower in social competence and effortful control (Diener & Kim, 2004).

Overall, research suggests that high levels of cortisol reactivity may impede effortful control. Based on this literature, higher levels of effortful control should predict lower levels of effortful control and because effortful control capacities increase substantially in preschool years (Rueda, Posner, & Rothbart, 2005) and mechanisms for cortisol production become stable from ages 3 to 3.5 (Watamura et al., 2004), this stage of development would be the most beneficial to further investigate this hypothesis.

Effortful Control and the Role of Intrusive Parenting

While theory and empirical evidence support the role of physiological changes as mechanisms that support the deployment of effortful control, the direction of effects between effortful control and other purported mechanisms of development is not certain. A prime example of this concerns the role of the early childhood environment, which is most frequently described as an important factor contributing to the development of effortful control (Eisenberg, 2009). There is certainly theoretical and empirical support for this view. Classic attachment theory suggests that exposure to consistent intrusive parenting, defined as over controlling, manipulative, overprotective, and unsolicited parental involvement (Baumrind, 1991; Becker, 1967), during early childhood interferes with the typical development of self-regulation (Bowlby, 1980; Chorpita & Barlow, 1998; Grolnick & Ryan, 1989; Karreman, Van Tuijl, Van Aken, & Deković, 2006). Further, research with preschoolers age 4 to 5 suggests that intrusive parents appear to undermine the development of independent coping skills and discourage children's independent regulation (Rubin, Cheah & Fox, 2001). This negative association appears to also be true for effortful control in particular. Specifically, research suggests that 22 to 33-month-old toddlers with more responsive, accepting, and emotionally available mothers, behaviors which are negatively correlated with intrusive parenting (McGoron, 2009), show greater effortful control relative to toddlers with more intrusive mothers (Kochanska et al., 2000). In addition, intrusive-overcontrolling parenting at age 3 is negatively associated with both concurrent assessments of effortful control (Karreman, Van Tuilj, Van Aken, Deković, 2008) and levels of effortful control assessed two years later (Taylor, Eisenberg, et al., 2013). Greater levels of maternal intrusiveness measured when children were 2 years-old was also associated with lower effortful control when children were 5.5 years-old (Graziano, Keane, & Calkins, 2010)

Again, the majority of developmental research assumes that parenting precedes, or predicts levels of effortful control in children (Cipriano & Stifter, 2010; Karreman, et al., 2009; Taylor, Eisenberg et al., 2013). That is, research designs have almost exclusively tested a unidirectional effect of parent behavior on children's levels of effortful control. However, given that both displays of effortful control and parenting are assessed at the level of behavior (that is, they are not bound by the same necessary direction-of-effects that apply to physiological underpinnings of behavior), this directionality is not implicit in their association. In fact, Bell's Parent-Child Interaction Theory (1968) suggests that it is equally pluasible that children elicit changes in parenting behaviors as parents try to adapt to their child's actions. Only a handful of studies have begun to investigate associations between parenting and effortful control in this way. Indeed, low levels of effortful control in toddlers appear to predict greater intrusive parenting in mothers two years later (Eisenberg et al., 2015). Similarly, greater effortful control in children ages 3 to 11 evokes greater positive parenting, more consistent discipline procedures, and less poor discipline (i.e. scolding or yelling as a main form of punishment; Tiberio et al., 2016). Similar to the postulate set forth in Parent-Child Interaction Theory, researchers interpreted this pattern of findings to reflect parents' attempts to adapt to their child's external behaviors. Specifically, because children low in effortful control tend to be less skilled in self-regulation (Posner & Rothbart, 2000), which leads to more problematic behaviors (Eisenberg et al., 2009; Essex et al., 2002), parents may implement more intrusive, controlling tactics in response to these problematic behaviors.

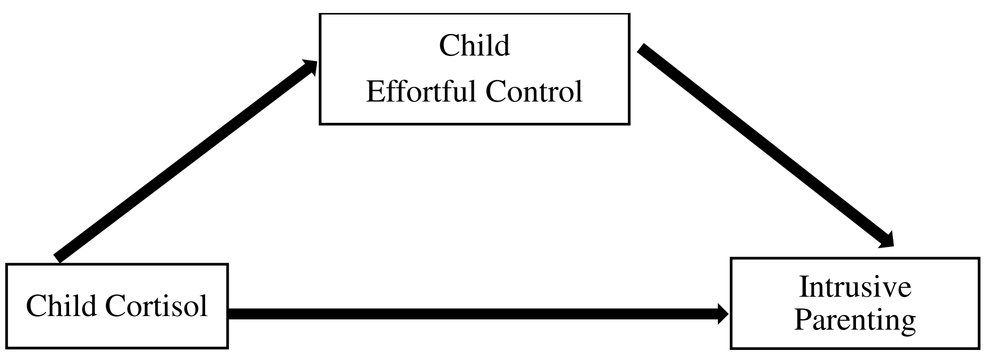
Parenting behaviors also appear to be associated with the mechanistic underpinnings of effortful control in children, including cortisol reactivity. In fact, supportive parenting, or parents who provide emotional encouragement, appears to mitigate children's cortisol reactivity in the presence of a stressful social task in children ages 8 to 10 (Hostinar, Johnson, & Gunnar, 2015). In contrast, those children who are insecurely attached to their parent show greater cortisol reactivity to social stressors, such as daycare, than those children who are securely attached (Nachmias, Gunnar, Mangelsdorf, Parritz, & Buss, 1996). Moreover, there is evidence to suggest that higher rates of intrusive parenting when children are 30-months-old predict higher levels of cortisol reactivity in children 42 months later (Taylor, Spinrad, et al., 2013), but the extent to which cortisol reactivity may predict intrusive parenting behaviors has not been examined.

If there is an association between child cortisol reactivity and parenting behaviors such that cortisol reactivity predicts intrusive parenting, understanding this association may provide insight as to how parents adapt to their child's basic biological regulatory mechanisms through the child's own observed behaviors. This is a sound hypothesis to investigate because, as previously noted, research has shown that a) reactive cortisol predicts effortful control and b) effortful control can evoke intrusive parenting, therefore reactive cortisol in young children should evoke parent intrusiveness.

The Current Study

As previously noted, research suggests that young children can have marked influences on intrusive parenting behaviors, but there is no research which has examined the influence of children's cortisol reactivity, an underlying biological facet of effortful control, on parenting behaviors. As such, I plan to assess the evocative effect of children's self-regulation on intrusive parenting. Specifically, I hypothesize that children's cortisol reactivity, a physiological underpinning of self-regulatory behaviors, will directly predict intrusive parenting behaviors. I further hypothesize that this association will be partially mediated by effortful control (Figure 1), a key self-regulatory behavior that emerges during early life. Thus, I hypothesize that greater cortisol in young children will predict decreased levels of effortful control, which will subsequently predict increased parent intrusiveness. Understanding the proposed associations would provide one possible explanation of how physiological reactivity to stress in early childhood can evoke controlling parenting tactics. Moreover, it will be valuable to know if this evocative effect occurs when children are as young as 3 years-old.

Figure 1. Proposed partial mediation of effortful control on the mediation of the child cortisol-intrusive parenting effect



METHODS

Participants

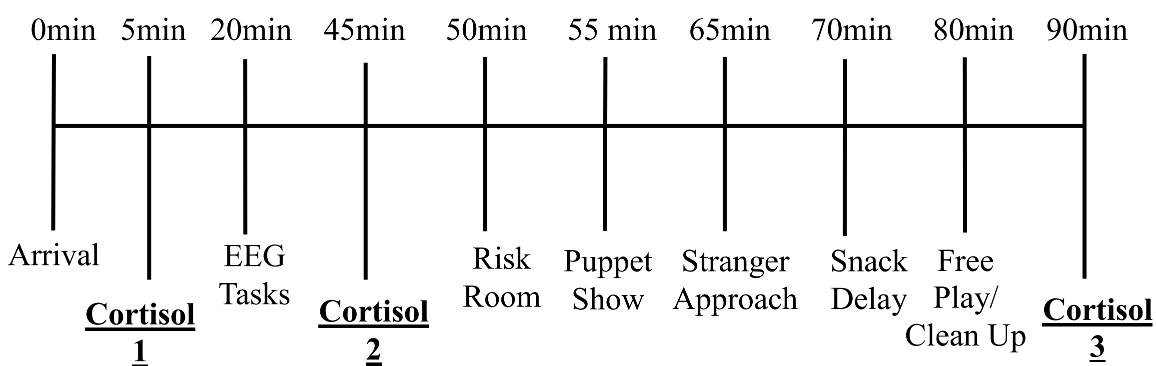
Families with 3.5-year-old children were contacted through fliers, in-person recruitment at local events, and mailings based on local birth records to participate in a longitudinal study of the development of cognition and emotion in preschoolers. Participants included 107 children who visited the laboratory at the first wave of data collection (M_{age}=3.60, *SD*= 0.20; 58.3% female) and their mothers (M_{age}=35.81, *SD*= 5.06) and fathers (M_{age}=37.90, *SD*= 6.29). Children largely came from two-parent households in which they lived with their heterosexual, biological parents. Participants were mostly Caucasian (95.8%, 3% Native American/Alaskan Native, 1% Asian) and Non-Hispanic/Latino (94.7%). Reported household income ranged from less than $15,000 to $91,000 or more: Less than $15,000 (2.22%), $16,000-$20,000 (4.44%), $21,000-$30,000 (7.78%), $31,000-$40,000 (6.67%), $41,000-$50,000 (6.67%), $51,000-$60,000 (12.22%), $61,000-$70,000 (11.11%), $71,000-$80,000 (7.78%), $81,000-$90,000 (7.78%), and $91,000 or more (28.89%).

Procedure

Primary and secondary caregivers were mailed a packet of questionnaires two weeks prior to visiting the laboratory. Mothers and fathers were asked to complete questionnaires independently. The primary caregiver, defined as the individual who was responsible for the majority of caretaking duties in the household, returned completed questionnaires when they accompanied their child to the lab. After informed consent was obtained, children completed three computer tasks while electroencephalogram (EEG) was recorded. Once these tasks were completed, children engaged in five different behavioral episodes from the Laboratory Temperament Assessment Battery (Lab-TAB) designed to assess children's reactivity to novelty; *Risk Room, Puppet Show, Stranger Approach, Snack Delay, and Free Play/ Clean Up* (Goldsmith, Reilly, Lemery, Longley, & Prescott, 1999). Because of the focus on effortful control and parenting behaviors in the current study, only the *Snack Delay* and *Free Play/Clean Up* episodes were considered further. An illustration of the sequence of laboratory procedures is provided in Figure 2.

Three saliva samples were collected from children throughout the course of the visit. The first saliva sample was collected upon arrival to the laboratory, the second sample was taken after the child completed the EEG assessment, and the third sample was taken upon the completion of the Lab-TAB episodes. Parents were compensated $30.00 for their time in the laboratory and an additional $5.00 per completed questionnaire packet.

Figure 2. Timeline of laboratory procedures



Measures

Physiological Regulation: Reactive Cortisol

Reactive cortisol was measured through the saliva samples collected during the laboratory visit. For saliva collection, each child was told to keep an unflavored synthetic polymer cotton swab under their tongue for one minute, saturating it with as much saliva as possible. The first sample was taken upon arrival at the laboratory. The second sample was taken approximately 30 minutes after arrival, and the final sample was collected after all behavioral paradigms were completed. Because cortisol peaks roughly 20-30 minutes after exposure to as stressor (Kirschbaum & Hellhammer, 2000), the cortisol samples used here reflect a baseline measurement (sample 1), the neuroendocrine response to arriving at the lab (sample 2), and the neuroendocrine response to emotionally-evocative interactions (sample 3).

After saliva collection, samples were stored at -80° C until they were sent to the University of Trier's Biochemical Laboratory to be assayed. Assays were run in duplicate on 100µl of saliva using a time-resolved fluorescence immunoassay (DELFIA). The mean intra-assay coefficient of variation was 7.3%. Cortisol values from each assay were mean composited. Values were then windsorized to within 3*SD* of the sample mean and natural log transformed. Reactive cortisol was quantified using area under the curve (AUC) estimation. For this study, I used area under the curve increase (AUC_i) which calculates the area under the curve from the first cortisol measurement and is meant to capture reactivity of the HPA axis (Pruessner, Kirschbaum, Meinlschmid, & Hellhammer, 2003). AUC_i was calculated as the sum of the average cortisol values at consecutive time points weighted by the duration of time between assessments minus the individual baseline value. AUC increase was selected over AUC ground[1] because AUC_i accounts for individual differences in baseline cortisol levels, thus providing a more stringent test of reactive changes in cortisol levels (Prussner et al., 2003). AUC_i values were not significantly related to parent reports of their child's activity 30 minutes prior to arrival, food eaten in the previous 30 minutes, children's physical symptoms, medications, or reports of recent stressful events (*t*s < 1.18, *p*s > 0.05).

Behavioral Regulation: Effortful Control

Effortful control was assessed via both observed behaviors and parent report surveys. Observed behaviors and parent reports were coded and scored separately before being mean composited into a single index.

Observed Effortful Control. The *Snack Delay* paradigm is a standardized laboratory episode used to measure individual differences in inhibitory control, a facet of effortful control, in preschoolers (Goldsmith et al., 1999). During this episode, the child was seated at a table with the experimenter. The experimenter placed a snack (most frequently M&Ms), selected by the primary caregiver, under a clear plastic cup and told the child "Do you like M&M's? We're going to play a game with M&Ms. Let me show you how to play. I am going to put an M&M under the cup and when I ring this bell, you can pick up the cup and eat the M&M." The experimenter rang the bell and encouraged the child to eat the M&M. The child completed a practice trial in order to ensure that s/he

[1] Substituting AUC ground yielded the same pattern of effects, although effects were not significant

understood the rules of the game before completing six experimental trials. At the beginning of each trial the experimenter said, "Let's play some more. Remember don't take the M&M until you hear the bell." Wait durations for each trial were 5 seconds, 10 seconds, 0 seconds, 20 seconds, 0 seconds, and 30 seconds.

Videos of Snack Delay were coded offline by trained graduate and undergraduate research assistants. Fidgeting (κ = 0.74) was coded on a four-point scale ranging from no fidgeting, defined as sitting quietly at the table (1) to intense fidgeting, defined as kicking legs, clapping hands, can't sit still in the chair, and bouncing in the chair (4). Latency to fidget was coded as the time in seconds from the start of the trial until the first fidgeting behavior. All coders were required to achieve a minimum reliability of κ = 0.70 on all behaviors before coding independently. Ratings for fidgeting were averaged across all trials for each child. Similarly, latency scores were reversed so that higher scores indicated higher fidgeting then averaged across all trials. Mean fidgeting and latency to fidget were standardized and composited into one global index of fidgeting.

Parent-Reported Effortful Control. Effortful control was also assessed using the Childhood Behavior Questionnaire Short Form (CBQ Short Form; Putnam & Rothbart, 2006). Mothers and fathers were asked to report on a 7-point scale (1 = *extremely untrue*, 7 = *extremely true*), how true descriptions were for their child within the past six months (e.g. Can wait before entering into new activities if s/he is asked to). Items previously identified as part of the effortful control scale (*n* = 26; Rothbart, Ahadi, Hershey, & Fisher, 2001), comprising attention focusing (moms α = 0.76, dads α = 0.82), inhibitory control (moms α = 0.67, dads α = 0.69), low intensity pleasure (moms α = 0.69, dads α =

0.80), and perceptual sensitivity (moms α = 0.77, dads α = 0.73) subscales, were mean composited. All subscales were significantly correlated for mothers (mean $r = 0.37$, $p < 0.05$) and fathers (mean $r = 0.45$, $p < 0.05$). Scores from each subscale were mean composited for mothers and fathers to reflect maternal and paternal reported effortful control (moms α = 0.69, dads α = 0.77). As maternal and paternal ratings were significantly correlated ($r = 0.54$, $p = 0.00$), both scores were collapsed across to create a single parent rating of effortful control.

Intrusive Parenting

Children and their primary caregiver (*n*= 82 mothers, *n* =17 fathers) participated in a *Free Play* and *Clean Up* episode conducted at the end of the laboratory visit (Gardner, 1997). During this episode, the child had the opportunity to play with a variety of age-appropriate toys with their parent for five minutes. At the beginning of the experiment, the parent and child were in the empty playroom and the experimenter came in and placed various toys in predesignated areas of the room. The experimenter then told the parent and child "you can play with the toys however you would like," then left the room. After five minutes had passed, the experimenter returned to the room and placed five plastic bins around the room that were labeled with pictures of the toys that were to be placed inside. Once the bins were in place, the experimenter said to the child "Okay, we are just about done for today, but this room needs to be cleaned up before we can go. These bins each have photos on them of the toys that need to go inside." The parent was then given the following instructions "(Parent's name), you can work with (the child), but s/he should clean up as many of the toys on their his/her own as possible. So, just do whatever you would normally do to get (the child) to pick up the toys on his/her own." The experimenter then left the room for five minutes before returning.

Videos of the Free Play and Clean Up were coded offline by trained graduate and undergraduate research assistants using a coding scheme developed by Winslow, Shaw, Bruns, & Keibler (1995). Parent intrusiveness was defined as the parent giving unnecessary commands, being physically manipulating or restricting the child, preventing the child from attempting tasks by doing it for them, or trying to unnecessarily direct the child's play behavior or goals. The maximum level of parent intrusiveness was coded on a four-point scale ranging from no intrusiveness (1) to highly intrusive (4) based on the highest rating of intrusiveness observed during each episode. Examples of intrusive parenting included offering a continuous barrage of stimulation or toys, overwhelming the child rather than observing his/her reaction, preventing the child from attempting tasks by doing it for them, and taking away objects while the child still appeared interested.

All coders were required to achieve a minimum reliability of $\kappa = 0.70$ on all behaviors before coding independently. Reliability for the coding of parent intrusiveness were high ($\kappa = 0.77$). Ratings from the Free Play and Clean Up episodes were significantly correlated ($r = 0.99$, $p < 0.00$) and were mean composited to create a single rating of parent intrusiveness for each child.

Missing Data

Area under the curve increase could not be calculated for 33 children due to the child providing only one or two of the three samples or too little saliva saturation. Three children refused to provide any saliva samples. Observed behaviors for snack delay could not be coded for three children due to computer/technical errors, two episodes were excluded due to a lack of props, and one episode could not be coded due to the child being out of the video frame during the task. The CBQ was completed by 97 mothers and 72 fathers. Missing parent questionnaire data was due to parents not returning questionnaire packets to the laboratory, completing only some questionnaires from the packet, or leaving items blank. Observed behaviors during the free play/clean up task could not be coded for two episodes due to computer/technical errors and five episodes were excluded due to a lack of props. For both free play/clean up and snack delay, one child was excluded from study procedures because he was too upset to continue participation. A missing value analysis suggested that data were missing completely at random (Little's MCAR $\chi2 = 29.96$, $p > 0.05$). Results presented here employ a complete-cases only analysis strategy, but remain unchanged if missing data are accounted for through the use of a Full-Information Maximum Likelihood procedure.

RESULTS

Preliminary Analysis

As is visible in Table 1, average child cortisol reactivity was low relative to expected levels for this age. However, the sample included a broad degree of variability. Effortful control showed the expected degree of variability given its calculation as a sum of standardized composites. Overall levels of parent intrusiveness were relatively low, though it is important to note that the full range of intrusive behaviors was observed. That is, parents were low in intrusiveness on average, but high levels of intrusiveness parenting were observed in this sample.

Bivariate correlations are shown in Table 2. Cortisol reactivity was not significantly correlated with effortful control (r = -0.07, $p > 0.05$) or intrusive parenting (r = 0.17, $p > 0.05$). Effortful control and intrusive parenting were also not significantly correlated (r = -0.08, $p > 0.05$).

Table 1. Descriptive statistics for child cortisol, effortful control and intrusiveness

	N	*Minimum*	*Maximum*	*M*	*SD*
Cortisol Reactivity	71	-36.76	52.25	-8.97	15.14
Effortful Control	107	-2.42	2.00	-0.03	0.77
Parent Intrusiveness	99	1.00	4.00	1.44	0.71

Table 2. Bivariate correlations among cortisol, effortful control and parent intrusiveness

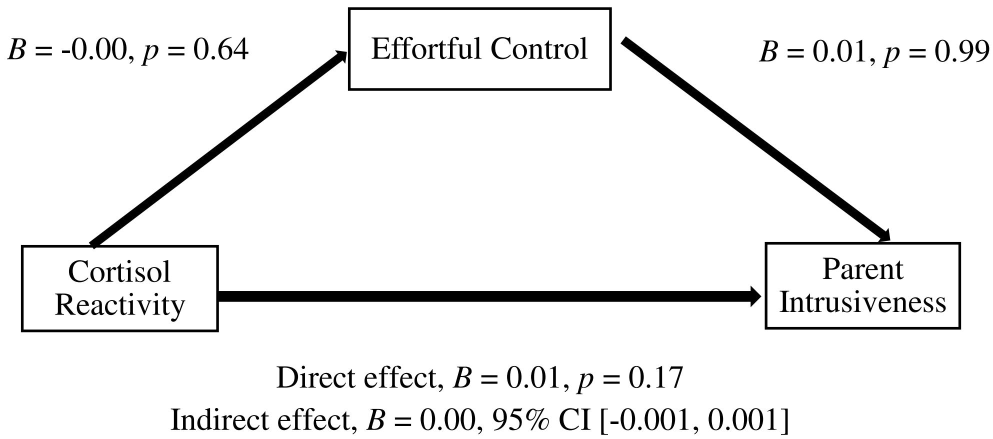
	2	3
1. Child Cortisol	-0.07	0.17
2. Effortful Control		-0.08
3. Parent Intrusiveness		

Primary Analysis

The Mediating Effect of Effortful Control

The proposed mediation model (Figure 1) was tested using the PROCESS macro for SPSS (Hayes, 2012). For this analysis, cortisol reactivity was entered as the independent variable, effortful control as the mediator, and parent intrusiveness as the dependent variable. As shown in Figure 3, no significant results were found. Specifically, the indirect effect of children's reactive cortisol on parents' intrusive behaviors through effortful control was not significant (B = 0.00, $SE(B)$ = 0.00, 95% CI = -0.001, 0.001).The direct effect of child cortisol reactivity on intrusiveness was similarly not significant (B = 0.01, $SE(B)$ = 0.01, p = 0.17). Children's cortisol reactivity did not predict effortful control (B = -0.00 $SE(B)$ = 0.01, p = 0.64), and the mediator variable, effortful control, did not significantly predict intrusiveness (B = 0.01, $SE(B)$ = 0.01, p = 0.99).

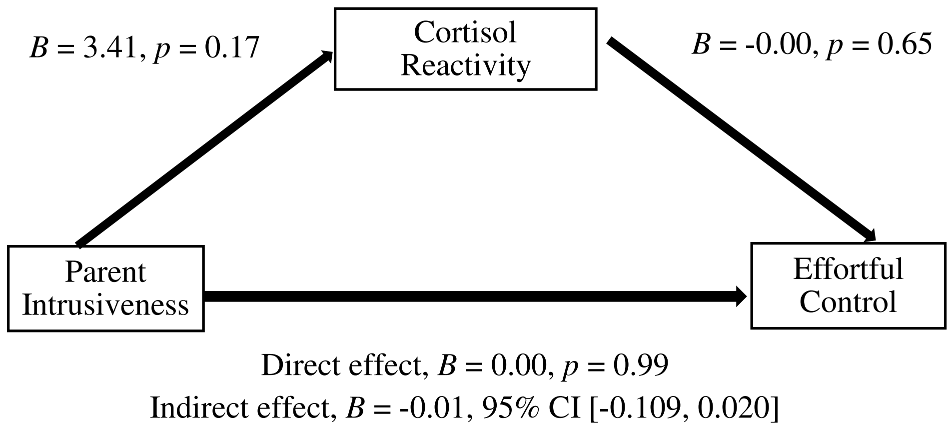
Figure 3. Mediation analysis indicates no significant direct effect or indirect effects of child cortisol reactivity on parent intrusiveness



Mediation with Intrusiveness Predicting Effortful Control

As child cortisol and intrusive parenting data were collected at the same time, I retested the mediation model through the traditional parent-to-child framework to see if nonsignificant findings were specific to the evocative effects model. In this second model, parent intrusiveness served as the independent variable, child cortisol reactivity as the mediator, and child effortful control as the dependent variable. As shown in figure 4, no significant results were found. Mediation analysis revealed that the direct effect of parent intrusiveness on child effortful control was not significant ($B = 0.00$, $SE(B) = 0.13$, $p = 0.99$). Parent intrusiveness did not predict cortisol reactivity ($B = 3.41$, $SE(B) = 2.75$, $p = 0.17$), and the mediator variable, cortisol reactivity, did not significantly predict effortful control ($B = -0.00$, $SE(B) = 0.01$, $p = 0.65$). The indirect effect was also not significant ($B= -0.01$, $SE(B)= 0.03$, 95% CI= -0.109, 0.020).

Figure 4. Mediation analysis indicates no significant direct effect or indirect effect of intrusiveness on effortful control



<u>Follow-up Analysis: The Moderating Effect of Effortful Control</u>

Given the developmental changes in effortful control that occur at this age, it is possible that evocative effects are linked to individual differences in children's effortful control rather than mean levels. That is, evocative effects may organize parent behavior only at certain levels of effortful control. To test this I conducted a follow-up analysis testing effortful control as a moderator of the association between child cortisol reactivity and parent intrusiveness (Table 3).

A two-step hierarchical regression analysis was conducted in SPSS. All predictor variables were mean centered prior to analysis. Child cortisol reactivity and effortful control were entered into the model predicting parent intrusiveness in Step 1. The interaction between child cortisol reactivity and mean centered child effortful control were entered in Step 2. The main effects of cortisol reactivity ($B = 0.05$, $SE(B) = 0.12$, $p = 0.65$) and effortful control ($B = 0.01$, $SE(B) = 0.01$, $p = 0.22$) were not significant.

However, an interaction emerged between cortisol reactivity and effortful control predicting levels of parent intrusiveness ($B = 0.02$, $SE(B) = 0.01$, $p = 0.05$).

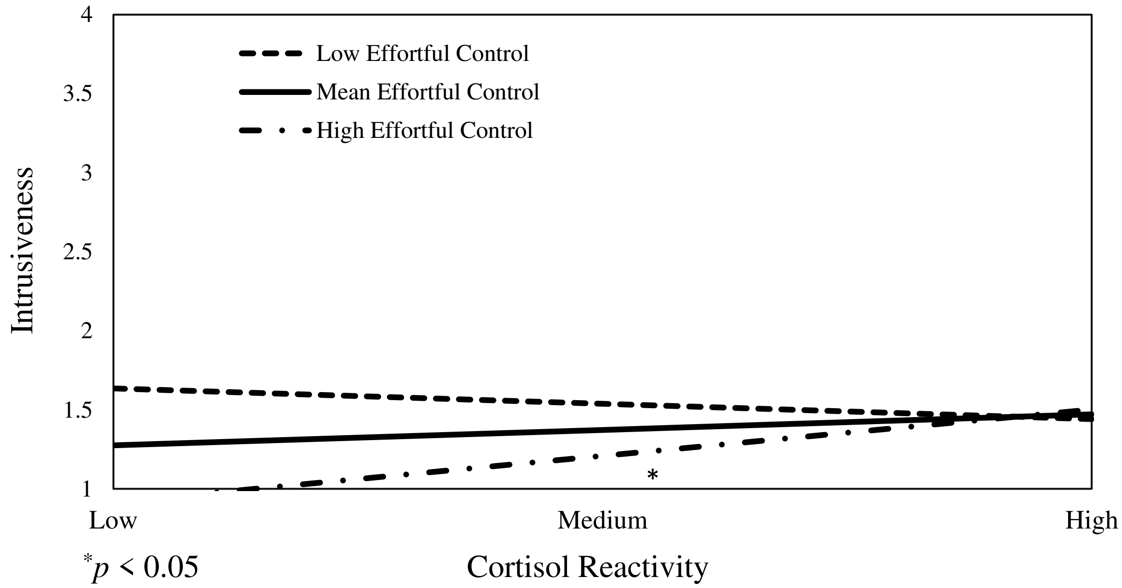
Consistent with the suggestions of Aiken & West (1991), I probed this interaction by recentering effortful control at low (-1*SD*) and high (+1*SD*) levels. As shown in Figure 5, when effortful control was low, greater cortisol reactivity predicted greater parent intrusiveness ($B = 0.02$, $SE(B) = 0.01$, $p = 0.02$). In contrast, when effortful control was high, there was no association between cortisol and intrusiveness ($B = -0.01$, $SE(B) = 0.01$, $p = 0.47$).

For comparison purposes, this moderation model was tested through a traditional parent-to-child effects framework. That is, cortisol reactivity was tested as the moderator with intrusive parenting predicting effortful control. None of the main effects in this model were significant and there was no significant interaction (all ts < 1.75, $p > 0.05$).

Table 3. The analysis of effortful control as a moderator of the association between cortisol reactivity and intrusiveness

	Intrusiveness			
Variable	*B*	*SE(B)*	*t*	*p*
Step 1				
Constant	-1.43	0.08	17.86	0.00
Cortisol Reactivity	0.05	0.12	0.49	0.65
Effortful Control	0.01	0.01	1.22	0.22
Step 2				
CortisolxEffortfulControl	0.02^{+}	0.01	1.97	0.05

Figure 5. Moderation analysis indicate a significant association between cortisol reactivity and intrusiveness at high levels of effortful control but not at low levels



*$p < 0.05$

GENERAL DISCUSSION

The primary goal of this study was to test the evocative effect of children's self-regulation on parents' intrusive behaviors. Specifically, I proposed a mediated association whereby greater cortisol reactivity, reflecting lack of self-regulation at the physiological level, would lead to less effortful control, indicating a lack of self-regulation at the behavioral level, which would evoke greater levels of intrusiveness in parents. Results did not support for my hypothesis, as cortisol neither directly nor indirectly influenced intrusive parenting. Results also did not support a traditional model, whereby parenting influenced processes of self-regulation in children. This model, too, revealed no significant effects. However, follow-up analyses provided initial evidence that effortful control moderates the relationship between cortisol reactivity and intrusive parenting. That is, when children were high in effortful control, greater levels of cortisol reactivity in children predicted greater levels intrusive parenting. Mediation and moderation findings are discussed in turn.

Despite my predictions, I found no evidence that cortisol reactivity in children directly evoked intrusiveness in parents, nor indirectly evoked intrusiveness through the child's levels of effortful control. Further, there was also no indication that parent intrusiveness was evoking effortful control behaviors indirectly through cortisol reactivity. The overall lack of significant effects in my model is somewhat surprising given that they are inconsistent with the previous literature suggesting a strong relationship between cortisol reactivity and effortful control (Gunnar et al., 1997) and between effortful control and parenting (Graziano et al., 2010; Taylor, Eisenberg et al., 2013). One potential reason for this discrepancy could be that effortful control, a traditionally multifaceted construct encompassing components of attention, inhibition, and behavior and emotion regulation, may be too narrowly defined in the current work. That is, both parenting and reactive cortisol may be more strongly associated with aspects of effortful control (i.e. emotion regulation) not accounted for by parent-report and observed measures in this study. The current study measures behaviors such as attention focusing, inhibitory control, fidgeting, and perceptual sensitivity of the environment as an index of effortful control. Although the definition of effortful control in the current study is consistent with previous research, other studies have utilized different parent report scales in order to measure effortful control in young children, as well as facial and behavior coding in lab behavior episodes (Kochanska, & Kim, 2014; Valiente et al., 2008; Vroman, & Durbin, 2015).

Some aspects of effortful control may also be easier for parents to pick up on as dysregulation (i.e. upset child or poor attention); thus, it might be that parents are responding to those behaviors more readily than others. Further, as temperament theory is biologically based in individual differences in reactivity and self-regulation (Derryberry & Rothbart, 1988), it is difficult to determine which aspects of effortful control are based on regulatory capacities or reactive dispositions or tendencies. As such, our null findings may be in part due effortful control being a dimension of reactivity, rather than self-regulation alone.

Another possibility is that the true association between physiological reactivity and observed behaviors is nonlinear, which would not have been tested in my mediation model. For example, reactive cortisol in excess leads to higher distress, purportedly as a result of interfering with self-regulatory capacities like effortful control (Stansbury & Gunnar, 1994), and very low levels of reactive cortisol are associated with chronic stress exposure (Van Ryzin, Chatham, Kryzer, Kertes & Gunnar, 2009). If it is true that a nonlinear association exists between cortisol reactivity and effortful control, then the mediation model that I originally proposed, whereby physiological dysregulation would positively predict behavioral dysregulation and intrusive parenting, may only be expected at high levels of reactivity. Although this sample is underpowered for a moderated mediation analysis, this represents an important avenue for future work.

A fourth potential explanation for a lack of effects in the hypothesized model is that only one dimension of parenting was assessed. We have previously shown that positive, supportive parenting behaviors are also high in this sample (Najjar & Brooker, 2017). Unlike intrusive parenting, positive and supportive parenting behaviors are negatively associated with children's cortisol reactivity (Kertes et al., 2009) and positively associated with children's effortful control (Eisenberg et al., 2005). Previous work suggests that positive and intrusive parenting behaviors may "offset" such that positive behaviors buffer potential effects of negative parenting practices (Pettit, Bates, & Dodge, 1997). Thus, it may be the case that low levels of effortful control elicit intrusive parenting behaviors for parents who are low in sensitivity. This, too, will be an important avenue for future work.

Another explanation for my null effects is that my mediation analysis was underpowered for detecting a significant indirect effect. Although this is a moderately sized sample for a longitudinal study in child development, it is still relatively small for detecting effects with small effect sizes. This problem is compounded by the amount of missing data for each variable. The recommended sample size for a mediation based on the most conservative mediation test is 127, yet even with less conservative methods a sample size of 120 is still recommended (Fritz & MacKinnon, 2007). Based on the current recommendations for mediation analysis, my sample is not large enough to observe significant effects. Therefore, in the future these associations should be tested with a bigger sample size.

Despite null findings for mediation, I did find evidence that effortful control moderated the relation between children's cortisol reactivity and parents' intrusive behaviors. Specifically, cortisol reactivity positively predicted parents' intrusive behaviors only when levels of effortful control were high. Cortisol reactivity and effortful control were unrelated at moderate and low levels of effortful control. Stated differently, it appears that when children were high in effortful control, greater levels of stress reactivity predicted greater levels of intrusive parenting. One possible explanation for this pattern of effects may be that parents are indeed looking to children for cues about how to act in novel and/or moderately stressful contexts, when the child needs aid regulating their behaviors. For children who are high in effortful control, it may be easier for parents to organize their own behaviors because children high in effortful control would have more predictable patterns of responding (Olson, Bates, Sandy, & Schilling, 2002). Thus, when children high in effortful control show greater reactivity to a stressor, the child's response may be easily identifiable as "out-of-character" by the parent who consequently implements more intrusive parenting tactics. Indeed, prototypically “intrusive” parenting behaviors may be beneficial when parents accurately interpret the need for such actions through a child’s cues (Kiel & Buss, 2011). This interpretation is consistent with Parent-Child Interaction Theory (Bell, 1968) and research suggesting that parent intrusiveness during infancy and early childhood stems from a need to support one’s child (Barber, 2002).

In contrast, for children who evidence low or moderate levels of effortful control, high levels of reactivity may be both less predictable and less alarming, making it difficult to identify contingencies between children’s reactivity and parent behaviors. That is, children who are low in effortful control may have parents who are always intrusive or parents who are inconsistently intrusive. If this is the case, it would be difficult to detect a statistical association between child reactivity and parenting behaviors given either too little (i.e., parents who are always intrusive) or too much (parents who are inconsistently intrusive) variability in parenting behaviors. This idea could be investigated in future work by parsing trait level intrusiveness in parents from situational or contextual intrusiveness, which is presumably more likely to be elicited by the child. This type of analytic approach has been followed in other domains (e.g., Shirtcliff et al., 2012).

Another potential explanation for an association between children’s physiological reactivity and parents’ intrusive behaviors at high, but not low, levels of effortful control is that children low in effortful control consistently exhibit poor regulatory behaviors, creating a near-constant need for parents to employ more intrusive parenting tactics.

Again, this lack of variability in parent and child behaviors would result in the absence of a statistical association. There is some evidence for this supposition as children who are low in effortful control often exhibit greater externalizing behaviors such as hyperactivity, disobedience, and aggression across various circumstances (Eisenberg et al., 2000). Further, externalizing behaviors are known to be positively associated with intrusive parenting (Eisenberg et al., 2015).

Overall, findings suggest that parents' behaviors are being guided by their children's actions, providing further support for Parent-Child Interaction Theory (Bell, 1968) which posits that parent-child interaction effects are bidirectional in early life. Specifically, these results suggest that parents are responding in a way that they feel their children need. However, these parenting behaviors could cause more harm long term as children are learning to regulate for themselves (Kopp, 1982; Kiel & Buss, 2013). This would mean that facets of effortful control, as temperament traits, have implications beyond just characterizing the child, they also influence parenting and begin to characterize the nature of the early environment. Thus, prevention and intervention programs may want to target both child and parent behaviors to enhance parent and child outcomes. Further, programs may want to target one behavior or another, which may produce a larger effect. Specifically, targeting children's behaviors alone may also, in turn, influence parenting (Silverman, Kurtines, Jaccard, & Pina, 2009).

Limitations and Future Directions

The current study is not without limitations. As previously noted, this experiment utilizes parent-report and observed behaviors such as attention focusing, inhibitory control, fidgeting, and perceptual sensitivity in order to measure effortful control in children. However, other indices, such as emotion regulation, may need to be included in order to form a well-rounded index of effortful control.

Additional limitations include the data from this investigation resulting from a cross-sectional design, making difficult to determine directionality of effects. Additionally, this sample comprised predominantly white families with two heterosexual parents from relatively low-risk backgrounds. Additional work is needed that investigates evocative effects on intrusive parenting in nonwhite and/or single-parent families and in families with same-sex parents is needed in order to generalize to a larger population. This would be especially important as different minority cultures are more selective on what is deemed harsh or authoritarian parenting behaviors (Baumrind, 1996).

Finally, in the current study, intrusive parenting was only measured for one parent and indexed through a single measure of observed parenting. Only one parent accompanied their child to the laboratory and, although this study measured intrusiveness from a sample of both mothers and fathers, the children who participated came from mostly two-parent households, leaving one parent's intrusiveness unaccounted for. Further, although intrusive parenting was observed at all levels during this task, there is a great need for additional measures of intrusive parenting in other contexts, such as at home and during stress-evoking tasks. Future studies should incorporate self-report measures of parent intrusiveness, as well as account for the presence of positive parenting during stressful tasks, in order to fully gain an understanding of the association between cortisol reactivity and intrusive parenting.

Conclusions

Overall, findings from this work reveal that for those children high in effortful control, greater cortisol reactivity predicts greater intrusive parenting. Previous research has been centered around how parenting practices influence child biology and behavior but no previous research up until this point has investigated how physiological and behavioral reactivity may work in tandem to evoke child parenting behaviors. These findings help shed light into how parenting practices are sensitive to child behavior and biology in the early environment and as effortful control in childhood can have implications for long term self-regulation and development it is important to continue to further investigate these parent-child associations.

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