Parental influences on executive functions in early childhood:

Differential effects of harsh and sensitive parenting

by

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Abstract

The aim of this study was to clarify the nature of the relations between specific dimensions of parenting (sensitivity and harshness) and cool and hot components of executive functions (EFs) in preschool children. As such, this study examined the additive and interactive effects of parental sensitivity and harshness on cool and hot EFs in early childhood. I hypothesized that both sensitive and harsh parenting would be associated with cool EFs, such that more sensitive parenting would be associated with better cool EFs while harsh parenting would be associated with poorer cool EFs in early childhood. I also hypothesized sensitive and harsh parenting would interact to affect hot EFs with sensitive parenting buffering the negative effect of harsh parenting on hot EFs. Participants were 144 36-month-old children and their mothers, drawn from a prospective cohort followed longitudinally from pregnancy. At 36 months, children's cool and hot EFs were measured using a latent variable approach (Wiebe et al., 2015). Mother-child interactions during free play, structured play, and waiting tasks were coded for maternal sensitivity and harshness. Structural regression was used to examine the additive and interactive effects of sensitive and harsh parenting on children's cool and hot EFs. Prenatal tobacco exposure status, child sex, children's verbal ability, and household income-to-needs ratio were included as covariates in all analyses. Harsh parenting was associated with poorer cool EFs while there was no association between sensitivity and cool EFs. Neither sensitive nor harsh parenting was significantly related to hot EFs, but there was a marginally significant interactive effect of sensitive and harsh parenting, such that for more sensitive parents, harsh parenting was related to better performance on hot EF tasks. The present study provided the first concurrent analysis of the relative contributions of sensitive and harsh parenting to children's cool and hot EFs. Findings contribute to our understanding of how specific aspects of parenting differentially relate to the components of EFs in early childhood.

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Introduction

The preschool period is marked by significant improvement in the ability to control one's thoughts, behaviours, and actions (Sokol & Müller, 2007) with improvements being driven, in part, by the development of executive functions (EFs) (Zelazo & Jacques, 1996). EFs are a set of higher-order cognitive processes necessary for goal-directed behaviour (Garon, Bryson, & Smith, 2008). At this age, EFs undergo rapid development (Clark et al., 2013) laying the foundation for the acquisition of more demanding socioemotional and cognitive competencies like emotion regulation (Carlson & Wang, 2007) and school readiness (C. Blair, 2002). Furthermore, individual differences in EFs during preschool are predictive of long term outcomes like social competence and coping skills in adolescence (Shoda, Mischel, & Peake, 1990). Because of the significance of the preschool period for the development of EFs, it is important to identify factors contributing to individual differences in emergent EF skills (C. Blair & Raver, 2012; Hughes & Ensor, 2009).

Emerging evidence suggests that the ecological context may support or compromise the development of young children's EFs (Hughes & Ensor, 2009; Raver, 2004). Given the importance of early social bonds for typical cognitive and socioemotional development, parents are thought to be one contextual factor of particular importance for the development of children's EFs (Bernier, Carlson, & Whipple, 2010). Recent research has identified specific dimensions of parenting that support or compromise the development of EFs, including sensitivity, the provision of a warm, supportive environment (Hill, Maskowitz, Danis, & Wakschlag, 2008; Razza & Raymond, 2013); and harshness, parental behaviours that undermine children's autonomy (Cuevas et al., 2014; Hill et al., 2008). However, these dimensions are interconnected (Grusec & Davidov, 2010). For example, harsh parental behaviours that occur within a warm parent-child relationship and harsh behaviours that occur in the absence of a warm parent-child relationship differentially impact developmental outcomes (McFadden & Tamis-Lemonda, 2013). This suggests that it is important to consider how negative and positive dimensions of parenting work together to affect the development of EFs in early childhood. This study examined how sensitive and harsh parenting act and interact to affect children's emergent EFs.

EFs During the Preschool Period

The development of EFs is closely linked to the development of the prefrontal cortex (PFC) (Moriguchi & Hiraki, 2009). EFs begin to emerge in the first year of life (Diamond & Goldman-Rakic, 1989; Johnson, 1995) with preschool being a time of substantial development in EFs. Between the ages of 3 and 5, gains in inhibitory control and set shifting are most dramatic between the ages of 3 and 3.75 (Clark et al., 2013; Wiebe, Sheffield, & Espy, 2012). On the *Go/No-Go* task, a measure of inhibitory control, accuracy on no-go trials improves from 47% to 74% (Wiebe et al., 2012), while accuracy and reaction time improve from 27% to 59% and from 3.83 s to 2.86 s on the set shifting component of *Shape School*, a measure of inhibitory control and set shifting (Clark et al., 2013). It is also during this time that children transition from perseverating on the *Dimensional Change Card Sort* task to being able to appropriately shift sets (Zelazo et al., 2003). Further, it is during the preschool period that individual differences in EF abilities begin to become stable over time (Carlson, Mandell, & Williams, 2004).

Additionally, EF abilities in preschool are an important predictor of proximal and distal development outcomes. EFs at this age predict language abilities (Hughes & Ensor, 2005), academic performance (C. Blair & Razza, 2007), social competence (K. Blair, Denham, Kochanoff, & Whipple, 2004), and behaviour problems (McIntyre, Blacher, & Baker, 2006; Zhou et al., 2007) in early and middle childhood. EFs in preschool are also predictive of more distal, long term, outcomes. For example, delay of gratification abilities in preschool predict SAT scores, likelihood of dropping out of high school, and physical aggression in young adulthood (Mischel, Shoda, & Rodriguez, 1989; Séguin, Nagin, Assaad, & Tremblay, 2004; Vitaro, Brendgen, Larose, & Tremblay, 2005). Given the great variability in performance on EF tasks in preschool, rapid improvement, and divergent developmental trajectories associated with EF abilities, it is important to identify factors contributing to individual differences in preschool children's EFs.

Hot and Cool EFs

Recent models of EFs suggest it can be divided into two separate but correlated components: "cool" EFs and "hot" EFs (Hongwanishkul, Happaney, Lee, & Zelazo, 2005; Willoughby, Kupersmidt, Voegler-Lee, & Bryant, 2011; Zelazo & Carlson, 2012). Cool EFs are the abilities involved in regulation under situations of cognitive load; for example, holding information in mind or overcoming an automatic response (Hongwanishkul et al., 2005; Wiebe et al., 2015; Willoughby et al., 2011). Hot EFs are the abilities needed to self-regulate under emotional or motivational load (Hongwanishkul et al., 2005). These include being able to assess the emotional or motivational significance of a situation and inhibit behaviour in an arousing setting (Brock, Rimm-Kaufman, Nathanson, & Grimm, 2009; Zelazo & Carlson, 2012). Cool and hot EFs also work together to guide goal-directed behaviours, forming part of a single co-ordinated decision making system (Zelazo & Cunningham, 2007). Hot EFs bias decision making in an adaptive fashion based on physiological reactions that predict rewards and punishments (Damasio, 1994), while cool EFs facilitate emotion regulation, delay of gratification, and reward processing (Zelazo & Muller, 2011).

The model of EFs as two separate but correlated constructs corresponds to neuroanatomical divisions in the brain. Cool EFs are subserved by dorsolateral PFC (dl-PFC) (Zelazo & Carlson, 2012). Dl-PFC is connected to the thalamus, basal ganglia, hippocampus, and primary and secondary areas of the neocortex (Zelazo & Muller, 2011). These connections suggest that the dl-PFC plays an important role in integrating sensory and memory information and regulating “intellectual function and action” (Zelazo & Muller, 2011, p.581), consistent with the role of cool EFs in self-regulation. Hot EFs are subserved by the ventral and medial parts of PFC (vm-PFC) which are part of a broader network involving the amygdala and limbic system (Zelazo & Muller, 2011). This suggests that the vm-PFC is involved in the regulation of basic limbic functions like emotion and motivation (Hongwanishkul et al., 2005; Zelazo & Muller, 2011), consistent with the definition of hot EFs. Furthermore, there are connections between the dl-PFC and vm-PFC linking the neural networks involved in cool and hot EFs together (Zelazo & Muller, 2011). These connections are thought to allow for the co-ordination of cool and hot EFs in guiding behaviour (Zelazo & Cunningham, 2007).

There is support for the hypothesized cool/hot distinction in children. First, confirmatory factor analyses suggest that cool and hot EFs are separate but correlated constructs in early childhood (Wiebe et al., 2015; Willoughby et al., 2011). Second, clinical research suggests that cool and hot EFs are differentially implicated in the development of psychopathologies (Castellanos, Sonuga-Barke, Milham, & Tannock, 2006; Rubia, 2011). For example, in ADHD, symptoms of inattention are associated with deficits in cool EFs; whereas, symptoms of hyperactivity/impulsivity are associated with deficits in hot EFs (Castellanos et al., 2006; Toplak, Jain, & Tannock, 2005). This lends additional support to the notion that cool and hot EFs are dissociable constructs in children.

PFC Development and Early Experience

Because of the protracted nature of PFC development, the environment is thought to have a large effect on the development of EFs (Bernier et al., 2010). The first few years of life are characterized by an overproduction of synapses followed by a prolonged period of gradual pruning (Nelson, Thomas, & De Haan, 2006). During this period, experience determines which synaptic connections persist and which are eliminated due to lack of use (Nelson & Bloom, 1997). PFC shows the most protracted postnatal development of any brain region with the shift from overproduction to pruning corresponding to the period of early childhood (Paus et al., 1999; Shaw et al., 2008). This extended period of overproduction and pruning leaves a substantial window for early experience to have a direct impact on the development of the PFC and, in turn, EFs (Bernier, Calkins, & Bell, 2016; Gunnar, Fisher, & the Early Experience, Stress, and Prevention Network, 2006).

Parenting and Children's EFs

Additive Effects of Sensitive and Harsh Parenting. Parenting is a crucial proximal factor affecting children's development (Baumrind, 1991; Campbell, 1997; Darling & Steinberg, 1993). Parenting is a multidimensional construct with different dimensions of parenting being important for the acquisition of different social-emotional and cognitive skills (Grusec & Davidov, 2010). For example, parental scaffolding predicts children's math abilities (Mattanah, Pratt, Cowan, & Cowan, 2005); while harsh discipline is an important predictor of the development of disruptive behaviour problems (Hoffman, 1970). Of particular interest in this study is how sensitive and harsh parenting act and interact to affect the development of EF abilities in children.

Parental sensitivity involves the provision of a warm supportive environment for children (Grusec & Davidov, 2010). As such, sensitive parenting reflects warm, sensitive, and contingent responses to children's behaviour; emotional availability; and the match between a parent's response and child's behaviour (Zeanah, Larrieu, Heller, & Valliere, 2000). Harsh parenting is marked by coercive and inconsistent parental behaviours (Hill et al., 2008), including over-controlling and intrusive behaviour, hostility, negative affect, and the use of punitive discipline strategies (McFadden & Tamis-Lemonda, 2013).

Sensitive and harsh parenting are thought to affect the development of children's cool and hot EFs. Kopp (1982) argues that the development of self-regulation (of which EFs are a component) is characterized by the movement from external control of behaviour to internal control, with internal control of behaviour requiring the child to internalize society's expectations of appropriate behaviour. When a child internalizes society's expectations, self-regulation becomes motivated by intrinsic factors instead of by the anticipation of external consequences (Grusec & Goodnow, 1994; Kopp, 1982). Sensitive and harsh parenting are thought to affect the internalization process (Grusec & Goodnow, 1994). For internalization to occur, the child must first accept their parent's viewpoint (Grusec & Goodnow, 1994). When parents are sensitive, their directives and commands are more likely to be seen as caring (Grusec & Davidov, 2010). Thus, children are more likely to listen to them and internalize their parent's requests for desirable behaviour leading to improvements in self-regulation over time (Eisenberg et al., 2005; Grusec & Goodnow, 1994). Conversely, if a parent is harsh, their child is more likely to immediately comply with their directives; however, the child is likely to reject their parent's viewpoint which makes internalizing what is considered socially acceptable behaviour more difficult, resulting in poorer self-regulation over time (Grusec & Goodnow, 1994; Talwar, Carlson, & Lee, 2011).

A well established body of literature demonstrates that sensitive and harsh parenting affect the development of children's cool EF abilities. When examined separately, sensitive parenting is predictive of better cool EFs in children both concurrently and longitudinally from infancy to early elementary school (Bernier, Beauchamp, Carlson, & Lalonde, 2015; Bernier, Carlson, Deschênes, & Matte-Gagné, 2012; Hughes & Ensor, 2005; Kraybill & Bell, 2013; Roskam, Stievenart, Meunier, & Noël, 2014). On the other hand, while harsh parenting is predictive of poorer cool EF abilities in children ages 3 and up concurrently and longitudinally

(Cuevas et al., 2014; Roskam et al., 2014). Furthermore, there is some evidence that these relations hold when the effects of sensitive and harsh parenting on cool EFs are examined simultaneously (C. Blair et al., 2011; Rhoades, Greenberg, Lanza, & Blair, 2011), although it is worth noting that these studies were not independent replications.

Research on the effects of parental sensitivity and harshness on the development of hot EFs is limited and mixed. Sensitive parenting has not been linked to hot EFs in children under the age of 3 (Bernier et al., 2012, 2010). In preschool children, the relation between sensitive parenting and hot EFs appears to be moderated by socioeconomic status, with only children from low income households showing improved hot EFs as a result of parental sensitivity (Bernier et al., 2012; Li-Grining, 2007; Rochette & Bernier, 2014). In kindergarten and school age children sensitive parenting is associated with better performance on hot EF tasks (Jacobsen, Huss, Fendrich, Kruesi, & Ziegenhain, 1997; Li-Grining, 2007; Merz et al., 2014; Razza & Raymond, 2013). Further, a clear link between harsh parenting and hot EFs has not been established. One study found that harsh parenting at 12, 24, and 36 months lead to poorer hot EFs in 5 year old children (Houck & Lecuyer-Maus, 2004) while a second study failed to find an association between these two variables (Rochette & Bernier, 2014). Thus, if sensitive and harsh parenting impact the development of children's hot EFs is an open question.

Interactive Effects of Sensitive and Harsh Parenting. Parental sensitivity has been proposed to moderate the effect of harsh parenting on children's EFs, such that harsh parenting only has a detrimental effect on the development of EFs when the parent is also low in sensitivity (Grusec & Goodnow, 1994; Kopp, 1982; Rohner & Britner, 2002). This is because harsh parenting is thought to be more likely to lead to the rejection of parent's directives and reduced internalization when the overall quality of the parent-child relationship is poor (Grusec & Goodnow, 1994; Rohner & Britner, 2002). When a parent is low in sensitivity, harsh parental behaviours (e.g., power assertions) are more likely to arouse anger and hostility in children making it more likely that they will reject their parent's directives leading to less internalization of what is considered socially acceptable behaviour and poorer EFs (Grusec & Goodnow, 1994). Conversely, highly sensitive parenting is thought to increase children's willingness to comply when faced with harsh parental behaviours because they desire to maintain a positive relationship with their caregiver (Grusec & Goodnow, 1994). In this context, harsh parenting is not theorized to lead to poorer EFs because children are still controlling themselves and internalizing their parent's requests for desirable behaviour (Grusec & Goodnow, 1994).

No research has directly tested this theory in regards to EFs. But, sensitivity moderates the effect of harsh parenting on the development of externalizing behaviour problems, aggression, and antisocial behaviour in children and adolescents, such that individuals with parents high in sensitivity had fewer behaviour problems associated with harsh parenting than individuals with parents low in sensitivity (Deater-Deckard, Ivy, & Petrill, 2006; McLoyd & Smith, 2002; Simons, Wu, Lin, Gordon, & Conger, 2000). As these types of behaviour problems are associated with deficits in hot EFs (Hobson, Scott, & Rubia, 2011; Kim, Nordling, Yoon, Boldt, & Kochanska, 2013), it is reasonable to predict that sensitive parenting would also moderate the effect of harsh parenting on hot EFs.

The Present Study

The aim of this study was to clarify the nature of the relations between sensitive and harsh parenting and cool and hot EFs in preschool children. First, this study examined if and how parental sensitivity and harshness predicted cool and hot EFs in early childhood. Consistent with previous research (C. Blair et al., 2011; Rhoades et al., 2011), I hypothesized that both sensitive and harsh parenting would be associated with cool EFs, such that more sensitive parenting would be associated with better cool EFs while harsh parenting would be associated with poorer cool

EFs in early childhood. Second, this study explored whether sensitivity and harshness interacted to predict EFs. Previous research has found interactions between sensitivity and harshness for externalizing behaviour problems (Deater-Deckard et al., 2006; McLoyd & Smith, 2002; Simons et al., 2000), and there is a link between these problems and hot EFs (Hobson et al., 2011; Kim et al., 2013). Therefore, I hypothesized that (a) there would be an interactive effect of sensitive and harsh parenting for hot EFs, but not cool EFs, and (b) the effect of harsh parenting would be stronger at lower levels of parental sensitivity, such that high harshness would be associated with poorer hot EF abilities only in children of parents low in sensitivity.

These questions were addressed in the present study using data from the Midwestern Infant Development Study (MIDS) cohort. This cohort has been followed from pregnancy to age 5. When children were 3 years old, mother-child interactions were videotaped during a variety of tasks allowing for the use of observational measures of sensitive and harsh parenting. Furthermore, the use of a latent variable approach to assess EFs was possible because multiple measures of hot and cool EFs were administered to the children in this cohort. Individual tasks were used as indicators of latent factors in a structural equation model. Individual EF tasks are often unreliable measures of EFs because they capture variation in EFs and in the abilities required to complete the task (e.g., verbal ability) (Miyake et al., 2000). A latent variable approach separates the variance due to EFs from the variance due to task-specific factors allowing for more accurate measurement of EFs. Thus, the MIDS dataset allowed me to test multiple hypotheses relevant to the research questions.

Methods

Participants

Participants were 144 3-year-old children (68 girls, 76 boys; *Mage* = 3 years 14 days, *SD* = 27 days; 56% PTE) and their mothers. Mothers were part of the Midwestern Infant Development Study (MIDS), a cohort recruited during pregnancy at two Midwestern sites (Carbondale, Illinois, and Lincoln, Nebraska) to participate in a study of the effects of prenatal tobacco exposure on neonatal attention and irritability (Espy et al., 2011). The focus of the present analyses is on a 36 month follow-up study conducted only at the Nebraska site. Family income ranged from under \$10,000 to over \$100,000 (*Mdn* = \$27,840) with 42% percent of families living at or under the poverty line. Children represented diverse racial and ethnic backgrounds, with mothers reporting that children were European American (n = 77), African American (n = 33), Hispanic or Latino (n = 27), Native American (n = 2), or multiracial (n = 5).

Mothers who reported binge drinking or illegal drug use, with the exception of occasional marijuana use, were excluded from the MIDS cohort, as were infants born preterm (< 35 weeks) or with birth complications known to affect developmental outcome (e.g., neonatal seizures) (Wiebe et al., 2015). Of the 164 mother-child dyads who participated in the 36 month follow-up, 15 were excluded for the following reasons: the child did not complete the EF battery (n = 13), data were missing for key covariates (n = 4), audiovisual malfunction (n = 4), and examiner error (n = 1). Dyads included in the final sample did not differ significantly from excluded dyads in terms of prenatal tobacco exposure status, maternal education, ethnicity, or child sex (Wiebe et al., 2015).

Procedure

At the 36 month follow-up, mother-child dyads returned to a developmental laboratory at the University of Nebraska. Children were tested individually by a trained research assistant over the course of three sessions, each separated by approximately one week. In the first session, children completed the Disruptive Behaviour Diagnostic Observation Schedule (DB-DOS), a structured clinic-based assessment designed to assess behaviours clinically relevant to the diagnosis of externalizing behaviour disorders in preschoolers (Wakschlag et al., 2008). The DB-DOS is made up of three modules, including one involving the parent-child dyad, which was video recorded and coded offline to assess parent-child interactions (Wakschlag et al., 2008). In the remaining two sessions, children completed a battery of tasks assessing cool and hot EFs and a measure of verbal ability. Tasks were administered in a fixed order to ensure that potential carry-over effects across tasks would be consistent for all participants. Adherence to experimental protocols was maintained by regular team meetings and reviews of session video recordings. After the completion of all three sessions, children received a small toy and mothers received a gift card as compensation.

Measures

EFs. The EF battery consisted of seven tasks measuring cool and hot EFs (Wiebe et al., 2011, 2015). The battery included three tasks assessing inhibitory control *(Big-Little Stroop*, *Preschool Go/No-Go*, and the inhibit condition of *Shape School*), two tasks assessing working memory *(Delayed Alternation* and *Nebraska Barnyard*), and two assessing delay of gratification (*Goody Shelf* and *Snack Delay*). Information on reliability and validity, as well as example of each task is included in Appendix 1.

The *Big-Little Stroop* task (adapted from Kochanska, Murray, & Harlan, 2000) was administered via computer. Children were shown large line drawings of everyday objects containing smaller embedded pictures that were either the same as or different from the larger drawings. Children were asked to name the smaller, embedded pictures. To prime the salience of the larger drawings, each trial was preceded by a brief presentation (730 ms) of the larger drawing. After a pretest to ensure that children could name each picture in the stimulus set, 24 trials were administered (50% conflict trials). The dependent measure was the proportion of correct responses on conflict trials.

The *Preschool Go/No-Go* task (adapted from Simpson & Riggs, 2006) was also administered via computer. In this task, participants were shown pictures of colored fish and were asked to “catch” the fish by pressing a button on a button box (75% of trials). On “no go” trials (25% of trials), an image of a shark appeared and children were told to “let it go” and withhold pressing the button on the button box. At the end of each trial a fishing net appeared as feedback. The net broke if the child caught a shark. The ‘‘go” and ‘‘no-go” stimuli were presented for up to 1500 ms, with an inter-stimulus interval of 1000 ms. The dependent measure for this task was d prime (d’), the difference between the z-scores for the hit rate and the false alarm rate (Stanislaw & Todorov, 1999).

The inhibit condition of *Shape School* (adapted from Espy, 1997) required children to name the colour of a cartoon stimulus when the stimulus had a happy face and to remain silent (i.e., suppress the naming response) when the stimulus had a sad face. Stimuli were presented using a computerized version of the task. First, a 12 trial control condition was administered in which children had to name the colours of the stimuli. Next, children were taught the rules of the task and six practice trials were administered. Last, children completed 18 test trials (12 color naming and 6 naming suppression). The dependent measure was accuracy on inhibit trials.

In *Delayed Alternation* (adapted from Espy, Kaufmann, McDiarmid, & Glisky, 1999; Goldman, Rosvold, Vest, & Galkin, 1971), children had to pick the correct location of a small reward on a testing board. The testing board had two wells and each well was covered with an identical neutral coloured cup with the reward being placed under one of the wells. The location of the reward alternated between the wells after each correct retrieval. To maximize performance, children needed to hold the previously rewarded location in mind. Trials were separated by a 10 second delay during which the reward was hidden out of the child's sight. During delays, the examiner would try to verbally distract the child. Children completed an initial training phase where they had to reach a criterion of three consecutive correct responses before continuing on to the test trials. Up to 16 test trials were administered. If children responded correctly nine consecutive times, the task was discontinued and children were given credit for any remaining trials. The dependent measure was the proportion of correct responses.

The *Nebraska Barnyard* task (adapted from Hughes, Dunn, & White, 1998) is a computerized task requiring children to remember a sequence of animal names and press colored buttons on a touch screen that corresponded to the correct sequence of names. During the training phase, children were introduced to 4 coloured pictures of barnyard animals arranged in a 2 x 2 grid of coloured boxes on the computer screen. When children pressed each animal box, the computer made the appropriate animal sound. After the training phase was complete, the animal pictures were replaced with coloured boxes where the colour of the box was selected to be as close to the animal's identity as possible (e.g., the ''frog" button was green). Children completed 4 practice trials where the examiner named each animal individually and the child was required to press the box that corresponded to the animal. During the test phase, children were required to remember a sequence of animal names and press the corresponding boxes correctly. The test phase began with a 2-word series and continued to a 6-word series. For each length, three test trials were administered. Children were required to get one correct at each length to move on. If the first two trials of a series were correct, children automatically advanced to the next length. The task was discontinued when children got all three trials in a given series correct. The dependent measure was a composite score of the summed proportion of correct responses at each span length.

Goody Shelf was administered as part of the DB-DOS (Wakschlag et al., 2008). The *Goody Shelf* task assesses children's ability to comply with instructions in the face of temptation. Children were asked to sit at a table while an experimenter unveiled an appealing set of toys on a small shelf and told the child that they could only look at, not touch, the toys. During a 5 minute delay children were given crayons and a piece of paper to draw on. The experimenter sat in the corner of the room and completed paperwork. If the child touched the toys, the examiner provided a series of increasingly supportive prompts (e.g., verbal reminders or moving the shelf). Each instance of a child touching a toy was coded for intensity on a scale from 1 to 3, where 1 represented brief touches and 3 represented sustained touches where the child was resistant to examiner prompts. The dependent measure was the total intensity score.

Snack Delay (adapted from Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996; Korkman, Kirk, & Kemp, 1998) assessed children's ability to wait for a delayed food reward. During a 4 minute delay children were instructed to put their hands on a place mat marked with two handprints and stand still, without talking, in front of M&M candies that were under a transparent cup. The task was videotaped and divided into 5 second epochs. Children's behaviour in each epoch was coded and then summed across all epochs until either the children ate the snack or the task ended. Children received up to 3 points for standing still, keeping their hands on the mat, and remaining silent. The dependent measures were (1) whether the child ate the snack during the delay, and (2) the summed score for the behaviour coding.

All tasks, except for *Preschool Go/No-Go*, were double coded (≥ 20%) (Wiebe et al., 2015). Inter-rater reliability was high (M = 91-100% for all tasks) (Wiebe et al., 2015).

Parenting. Mother-child dyads were videotaped completing the parent context of the DB-DOS (Wakschlag et al., 2008). The parent context consisted of four 5 minute parent-child interactions, including putting away crayons, completing puzzles, waiting, and free play (Hill et al., 2008). The procedure was explained to the mother before starting the parent context and flip cards with instructions were provided throughout the context. Transitions between tasks were marked by the ringing of a bell. Parent-child behaviour was not scripted and mothers were encouraged to act as they normally would.

Parental behaviour was coded using the Parenting Clinical Observation Schedule (P-COS), a structured observational measure designed to assess competent and problematic parenting behaviours (Hill et al., 2008). Behaviour was coded to assess sensitivity (scaffolding, responsiveness to positive behaviours, warm affection, positive engagement, labelling, intensity of positive affect, and pervasiveness of positive affect), and harshness (hostile behaviour, verbally aggressive discipline, physical discipline, power struggles, emotional misattunement, intensity of angry/irritable affect, and pervasiveness of angry/irritable affect). A description of each item and examples are presented in Appendix 2. Behaviours were coded globally (i.e., codes captured parental behaviours across all interactions) on a 4-point scale ranging from 0 (*no evidence of behaviour*) to 3 (*high levels of behaviour*). Coders watched videos twice before assigning final codes. Scores for the two scales were summed and used as the indices of sensitive and harsh parenting.

Coding was completed by one master-level and two bachelor-level coders who were trained to reliability (at least 80% exact agreement on each item) by a master coder involved in the development of the coding scheme. Ongoing reliability was maintained through weekly coding meetings and disagreements were resolved by consensus. Twenty percent of the videos were double coded by all three coders. Inter-rater reliability was high for these videos (κ = .88). The P-COS has been shown to have adequate internal consistency (α = .66 – .76) and good construct validity (moderate correlations with the Parenting Dimensions Inventory-Short Version and Coping with Children's Negative Emotions) (Hill et al., 2008). However, internal consistency for the sensitivity (α = .65) and harshness scales (α = .59) was slightly lower in this sample.

Covariates. Prenatal tobacco exposure, child sex, child verbal ability, and family socioeconomic status were included as covariates. Mothers reported on the number of cigarettes smoked each day at 14, 28, and 42 weeks gestational age and provided urine samples which were tested for cotinine, a metabolite of nicotine (Espy et al., 2011). Children were classified as being exposed to tobacco prenatally if their mothers reported smoking and/or if their mothers had cotinine levels over 50 ng/mL (Wiebe et al., 2011). Child sex was reported at 42 weeks gestational age. Children's verbal ability was assessed at 36 months using the Peabody Picture Vocabulary Test 4 (PPVT-4; Dunn & Dunn, 2007). This task is a standardized measure of receptive vocabulary with evidence for reliability (M = .94) and validity (M = .93) (Dunn & Dunn, 2007). Household income-to-needs ratio was used to index socioeconomic status (McLoyd, 1998). It was calculated by dividing mother-reported family income by the federal poverty threshold adjusting for family size when children were 36 months old (McLoyd, 1998).

Analytic Strategy

Univariate distributions for all variables were examined for non-normality and outliers. Outliers were trimmed to 2 standard deviations from the mean. In total, 5% of the data in the sample was missing. In most tasks, missing data was under 8%. The inhibit condition of *Shape School* had the highest rate of missing data at 33% with missing data being due to: lack of task-relevant knowledge (n = 23), refusal to participate (n = 12), and task noncompliance (n = 12). To minimize the number of participants lost due to missingness on exogenous variables, missing PPVT scores were replaced with the standardized verbal ability score on the Woodcock-Johnson III-B Test of Cognitive Ability (Woodcock, McGrew, & Mather, 2001), administered at 5 years.

Otherwise, missing data was dealt with using full information maximum likelihood estimation using an expectation maximization algorithm.

Structural equation modeling (SEM), using MPlus 7.3 (Muthén & Muthén, 2012), was used to test the hypotheses. Model fit was assessed using the chi-square (χ^2) statistic, root mean square error of approximation (*RMSEA*), comparative fit index (*CFI*), and standardized root mean square residual (*SRMR*). Cut-off values to determine good fit were .06 for the *RMSEA*, .95 – 1.00 for the *CFI*, and less than .08 for the *SRMR* (Hu & Bentler, 1999). Cut-offs to determine adequate model fit were a *RMSEA* of .06 – .08, .90 – .94 for the *CFI*, and less than .08 for the *SRMR* (Hu & Bentler, 1999; Kline, 2011). The chi-square difference ($\Delta\chi^2$) test was used to compare nested models (Kline, 2011). Two models were compared each time and when the test was significant ($p < .05$), the least constrained model was retained; otherwise, the more parsimonious model was retained. Main and interaction effects were deemed significant at an alpha level of .05.

Two step structural regression was used to examine whether sensitive and harsh parenting predicted cool and hot EF abilities in preschool (Kline, 2011). In step one of the regression, confirmatory factor analysis (CFA) was used to develop the latent constructs of cool and hot EFs (Kline, 2011). To determine the latent factor structure of these variables, one factor, two factor, and three factor models were tested. Modifications were made to the models based on the modification indices in MPlus and were theoretically informed (Kline, 2011). The best fitting model, using the aforementioned cut-offs, was retained and used in step two of the structural regression. In step two, the predicted structural regression model was tested by adding directional paths between each measure of parenting and each component of EFs (Kline, 2011). Covariates were entered after making modifications to the model.

Moderation was tested separately for cool and hot EFs using a series of structural regression models. First, the predictors were mean-centered, and then a product term was calculated to represent the interaction between sensitivity and harshness. Next, a model was tested in which the effects of the interaction term on cool and hot EFs were estimated. Third, a model where the effect of the interaction term on cool EFs was constrained to 0 was estimated to test for a moderation effect on cool EFs. Fourth, a model in which the effect of the interaction term on hot EFs was constrained to 0 was estimated to test for a moderation effect on hot EFs. The chi square test of model fit for the constrained model being significant was taken as evidence of moderation (Kline, 2011). Conceptual models are presented in Figure 1.

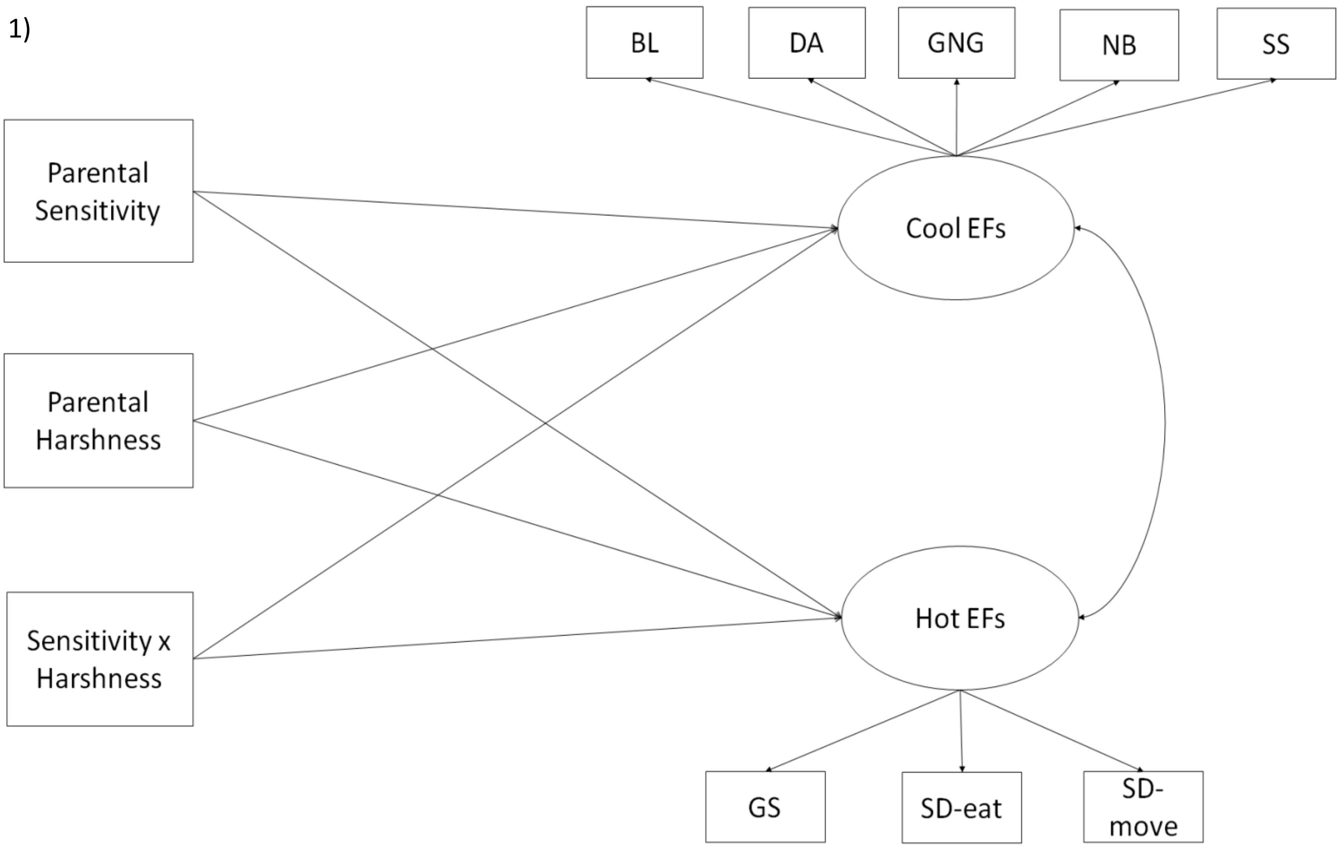
Results

Descriptive Statistics

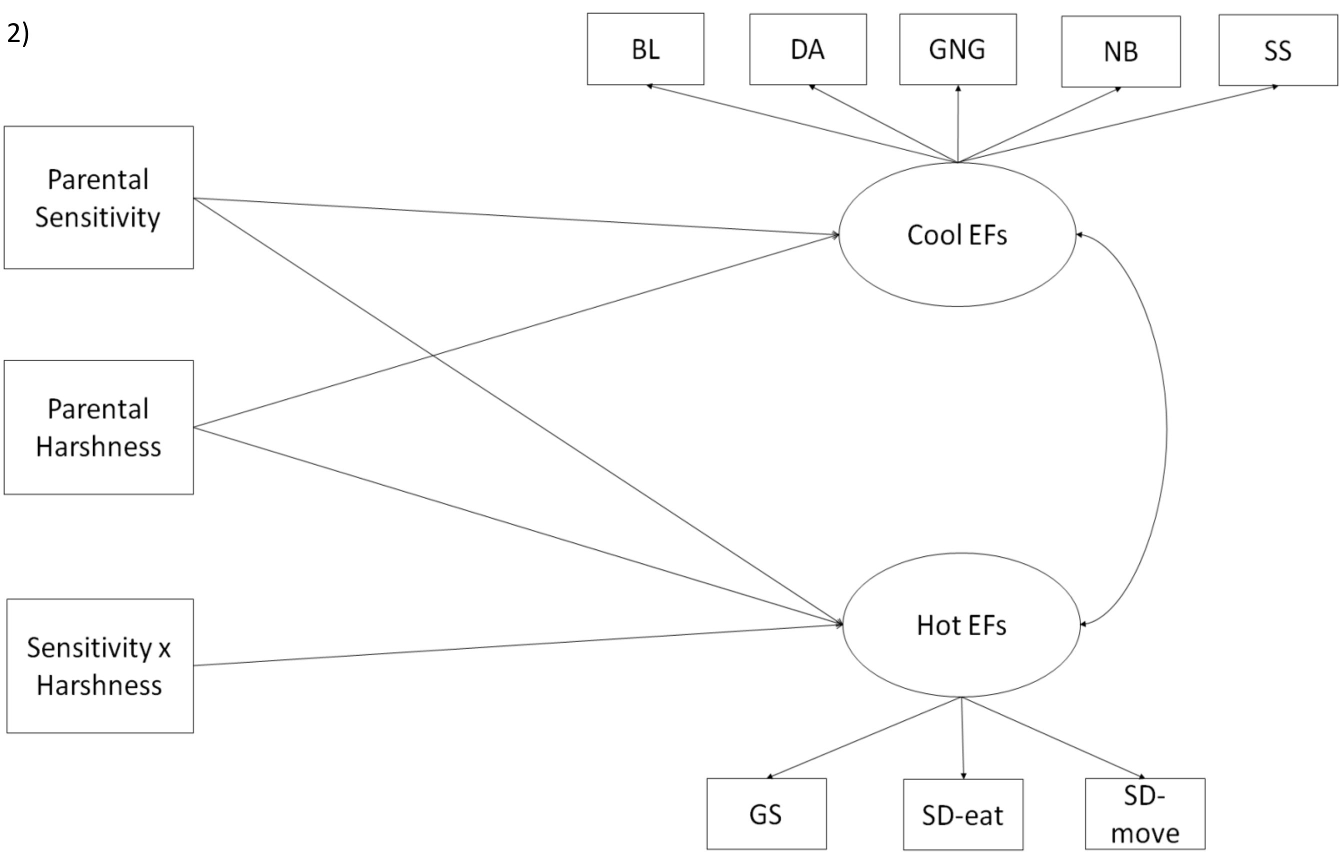
Descriptive statistics for all main variables used in the analyses are presented in Table 1 and correlations among these variables are presented in Table 2. Sensitive parenting and harsh parenting were significantly and moderately correlated with each other. Generally, the correlations among the covariates and measures of parenting were not significant, similar to the correlations among the covariates. Correlations among the tasks assessing cool EFs were generally significant but tended to be small in magnitude. In contrast, correlations among the tasks assessing hot EFs were significant and moderate to large. Most correlations across cool and hot EF tasks were not significant. Most of the correlations across the predictors and EF tasks were also not significant with the exception of the correlations among children’s verbal ability and EF tasks which were significant and moderate in magnitude.

Figure 1

1)


BL
DA
GNG
NB
SS
Parental Sensitivity
Parental Harshness
Sensitivity x Harshness
Cool EFs
Hot EFs
GS
SD-eat
SD-move

2)


BL
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SS
Parental Sensitivity
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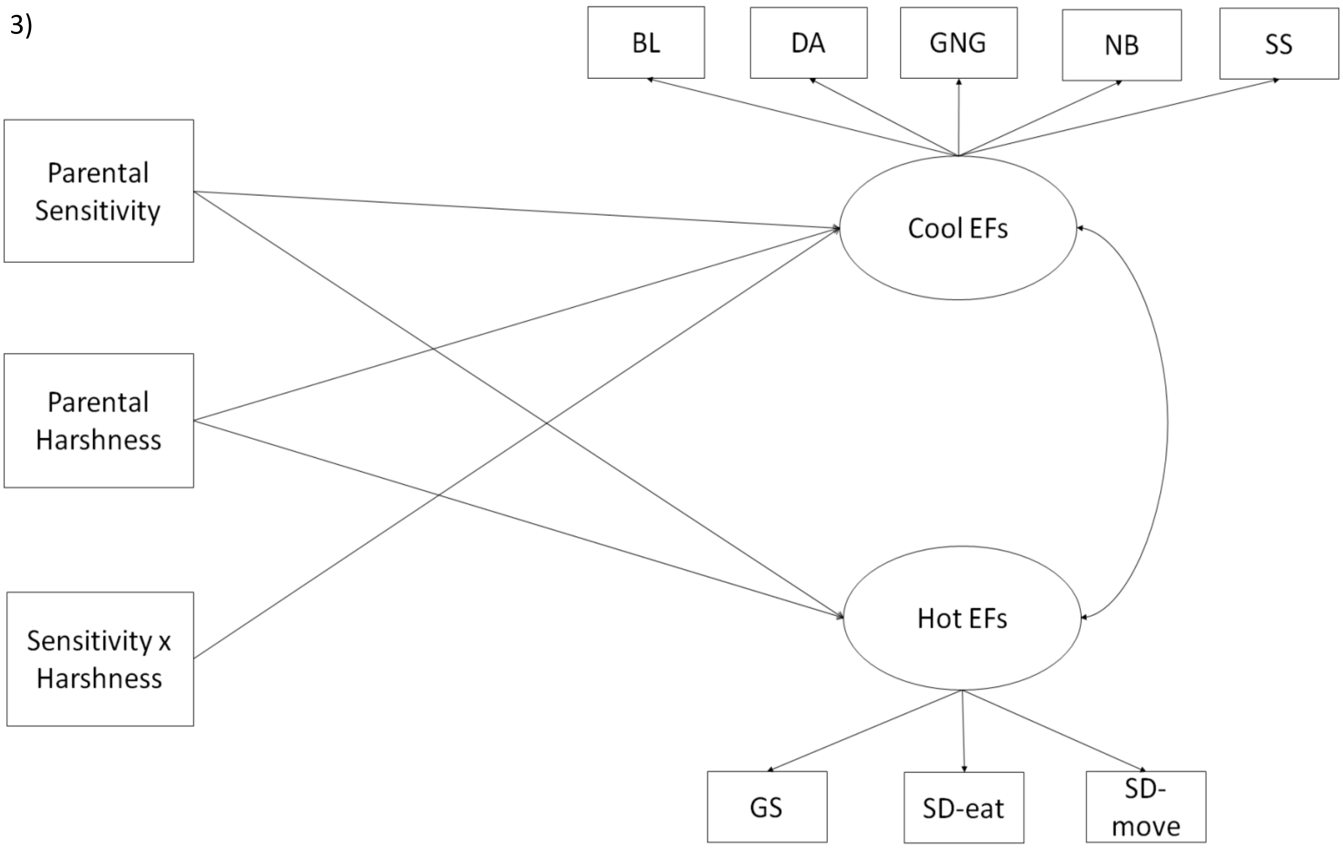
3)



Conceptual model illustrating approach to testing for moderation for hot and cool EFs. 1) Effects of the interaction term on both cool and hot EFs are estimated. 2) To test for a moderation effect on cool EFs, the effect of the interaction term on cool EFs is constrained to 0; model fit is compared to Model 1. 3) To test for a moderation effect on hot EFs, the effect of the interaction term on hot EFs is constrained to 0; model fit is compared to Model 1.

Table 1

Descriptive statistics for the measures of parenting, covariates, and EFs

Construct	N	M	SD	Range
Maternal sensitivity (composite score)	144	14.10	2.99	7.00 – 20.00
Maternal harshness (composite score)	144	1.31	1.84	0.00 – 10.00
Prenatal Tobacco Exposure (% exposed)	144	55.50%		
Child Sex (% female)	144	47.20%		
PPVT-4 (standardized score)	144	95.15	14.89	64.00 – 136.00
Income-to-needs ratio	144	1.45	1.62	0.00 – 17.53
Big-Little Stroop (conflict trial accuracy)	133	24.70	24.77	0.00 – 100.00
Go/no-go (d-prime)	139	0.54	1.00	-1.37 – 3.12
Shape School Inhibit (accuracy)	97	36.07	26.81	0.00 – 100.00
Delayed Alternation (accuracy)	139	0.50	0.18	0.00 – 0.94
Nebraska Barnyard (composite score)	133	3.33	1.73	0.00 – 8.06
Goody Shelf (rule-breaking; reversed)	134	29.55	7.21	0.00 – 33.00
Snack Delay (ate treat; reversed)	134	1.68	0.47	1.00 – 2.00
Snack Delay (movement score)	138	50.91	32.13	3.00 – 117.00

Table 2

Correlations between measures of parenting, covariates, and EFs

Measures	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. Sensitivity	-0.42**	0.00	-0.05	0.08	0.09	0.05	0.00	0.17	-0.01	0.00	0.07	0.13	0.07
2. Harshness	--	0.18*	0.12	-0.06	-0.08	-0.08	-0.15^{+}	-0.09	-0.11	-0.07	-0.31**	-0.10	-0.07
3. Prenatal tobacco exposure		--	-0.06	-0.07	0.01	-0.13	0.01	-0.12	0.01	-0.08	-0.17^{+}	-0.24**	-0.27**
4. Sex			--	0.08	0.26**	0.11	0.10	0.07	0.07**	0.02	-0.14	-0.07	-0.12
5. PPVT				--	0.24**	0.37**	0.35**	0.16	0.31	0.49**	0.13	0.20*	0.23**
6. Income-to-needs ratio					--	0.10	0.23**	0.03	0.12	0.11	0.01	0.11	0.06
7. Big-Little Stroop						--	0.24**	0.30**	0.23**	0.20*	0.03	0.12	0.30**
8. Go/No-Go							--	0.29**	-0.20*	0.35**	0.19*	0.09	0.11
9. Shape School								--	0.14	0.06	0.09	0.12	0.22*
10. Delayed Alternation									--	0.31**	0.13	0.20*	0.24**
11. Nebraska Barnyard										--	0.14	0.07	0.13
12. Goody Shelf (reversed)											--	0.36**	-0.42**
13. Snack Delay (movement score)												--	-0.75**
14. Snack Delay (ate treat; reversed)													--

Note: $^{+}$ $p < .10$; * $p < .05$; ** $p < .01$.

Data Reduction

Before conducting SEM analyses, several dependent measures (*Goody Shelf* and *Snack Delay* movement scores) were standardized to equalize the range of variance across indicators, and, if necessary, scores were reflected so that a higher score always represented better EFs.

Next, the factor structure of cool and hot EFs was evaluated using CFA (Wiebe et al., 2015). Indices of model fit and model comparisons are summarized in Table 3. The best-fitting model had two factors reflecting cool EFs and hot EFs. All factor loadings were statistically significant, and standardized factor loadings ranged from .42 to .56 for the cool EFs factor and .44 to .97 for the hot EFs factor. For cool and hot EFs, tests of measurement invariance supported invariance by sex at the configural, metric, and scalar levels. To establish scalar invariance, it was necessary to constrain the residual variance of the snack delay (ate treat) indicator to 0.

Do Sensitive and Harsh Parenting Predict EFs in Early Childhood?

When cool EFs and hot EFs were regressed on sensitive and harsh parenting, harsh parenting had a marginally significant effect on cool EFs (b = -.13, SE = .07, p = .052), such that harsher parenting was associated with poorer performance on cool EF tasks in children. There was no effect of sensitive parenting on cool EFs (b = -.01, SE = .04, p = .74). Neither sensitive (b = .01, SE = .03, p = .70) nor harsh parenting (b = -.04, SE = .06, p = .46) significantly predicted hot EFs. This model showed adequate fit to the data, $\chi^2(31) = 47.29$, p = .03, $RMSEA$ = .06, CFI = .92, $SRMR$ = .06.

Next, prenatal tobacco exposure status, child sex, child verbal ability, and income-to-needs ratio were added to the model as covariates (see Figure 2). Harsh parenting significantly predicted cool EFs (b = -.18, SE = .09, p = .04), such that harsher parenting was linked to poorer

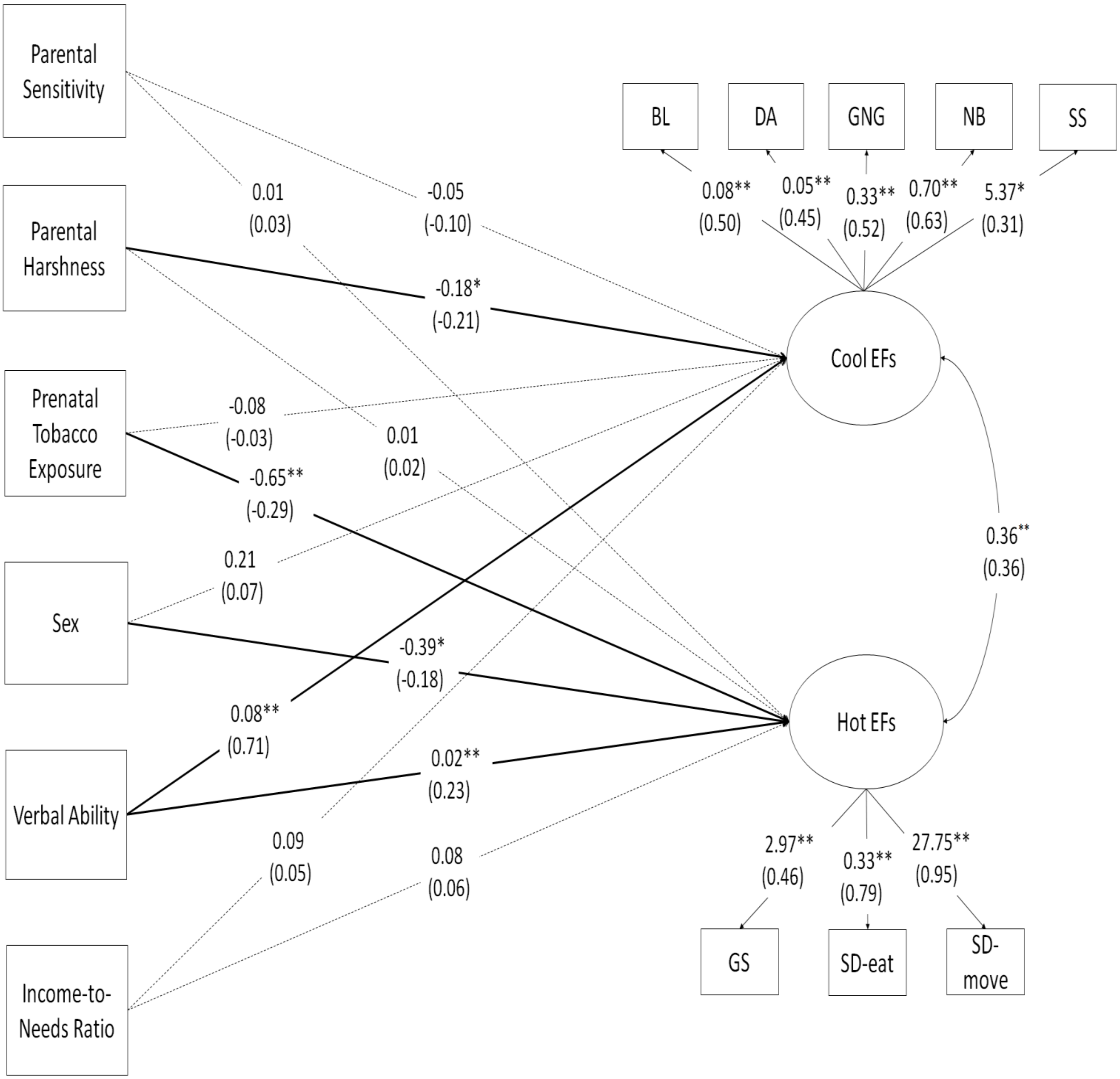
Table 3

Model fit indices for all tested CFA models of EFs

Model (number of factors)	χ^2	*Df*	*P*	*RMSEA*	*CFI*	*SRMR*	Model comparison	$\Delta\chi^2$	*df*	*p*
1. Unitary EF (1)	64.07	20	.00	.12	.78	.10				
2. Cool and hot EF (2)	26.13	19	.13	.05	.96	.05	1 vs. <u>2</u>	37.94	1	.00
3. Inhibitory control, working memory, and hot EF (3)	24.04	17	.12	.05	.97	.05	<u>2</u> vs. 3	2.09	2	.35

Note. For model comparisons, the preferred model is underlined. Where two nested models showed equivalent fit to the data, the more parsimonious model was preferred.

Figure 2



Path diagram illustrating the effects of parental sensitivity and harshness on children's cool and hot EFs. Unstandardized (standardized) parameters are presented; error variances are not shown.

* *p* < .05; ** *p* < .01.

performance on cool EF tasks in children. Harsh parenting accounted for 21% of the variability in cool EF performance. The effect of sensitive parenting on cool EFs was not significant (b = -.05, SE = .05, p = .33). Similar to the previous model, neither sensitive parenting (b = .01, SE = .03, p = .74) nor harsh parenting (b = -.01, SE = .06, p = .88) predicted hot EFs. Model fit was good, $\chi^2(55) = 63.24$, p = .21, $RMSEA$ = .03, CFI = .97, $SRMR$ = .05.

Regarding the effects of the covariates on cool EFs and hot EFs, children's verbal ability significantly predicted both cool EFs (b = .08, SE = .02, $p < .01$) and hot EFs (b = .02, SE = .01, $p < .01$), such that as children's verbal abilities improved so too did their cool and hot EFs. Prenatal tobacco exposure predicted hot EFs (b = -.65, SE = .20, $p < .01$) but not cool EFs (b = -.08, SE = .28, p = .78). Mothers who smoked during pregnancy had children with poorer hot EF abilities. Sex significantly predicted hot EFs (b = -.39, SE = .19, p = .04), such that boys had poorer hot EFs than girls. Sex did not predict cool EFs (b = .21, SE = .29, p = .46). There was no significant effect of income-to-needs ratio on either cool EFs (b = -.09, SE = .16, p = .59) or hot EFs (b = .08, SE = .10, p = .47).

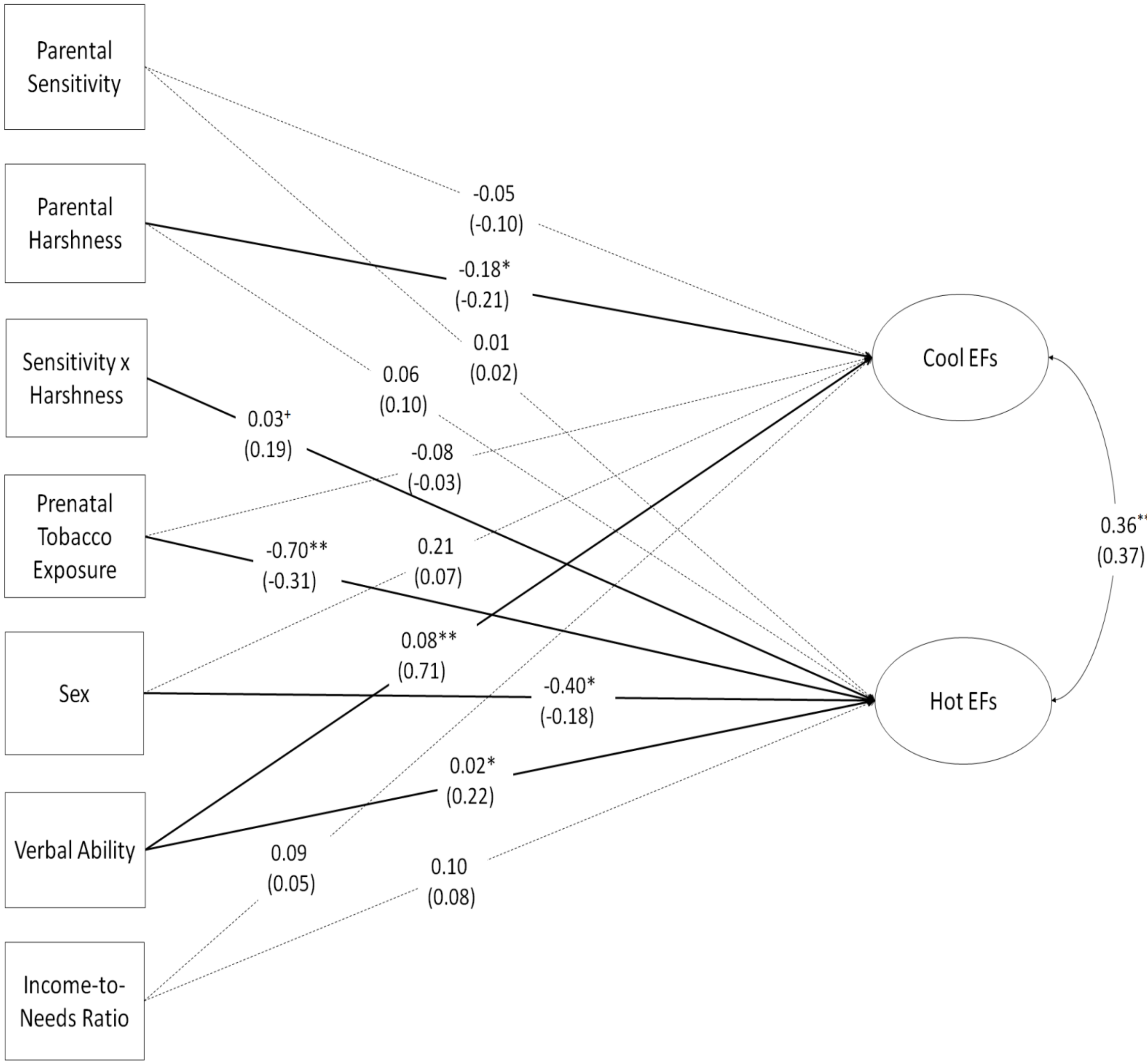
Do Sensitive and Harsh Parenting Interact to Affect Cool and Hot EFs?

As a first step in exploring the potential interactive effects of sensitive and harsh parenting on cool and hot EFs, a product term, representing the interaction between sensitive parenting and harsh parenting, was calculated. This term was added to the final model from the previous research question and then a model in which all parameters were free to vary was estimated. This model fit the data well, $\chi^2(61) = 70.32$, p = .19, $RMSEA$ = .03, CFI = .97, $SRMR$ = .05.

Because I expected the interaction between sensitive and harsh parenting to differentially affect cool and hot EFs, I tested for moderation separately for cool EFs and hot EFs. To test for the effect of the interaction term on cool EFs, I estimated a model in which the interactive effect of parenting on cool EFs was constrained to 0. This model fit the data well, $\chi^2(62) = 70.33$, $p = .22$, *RMSEA* = .03, *CFI* = .97, *SRMR* = .05. Model fit was equivalent for the constrained model and unconstrained model, in which the interactive effect of parenting on cool EFs was estimated, providing evidence against moderation ($\Delta\chi^2(1) = .01$, $p = .94$). Therefore, the constrained model was adopted. To test for a significant interactive effect of parenting on hot EFs, I estimated a model where the effect of the interaction term on hot EFs was constrained to 0. Model fit was good, $\chi^2(62) = 73.90$, $p = .14$, *RMSEA* = .04, *CFI* = .96, *SRMR* = .06. The constrained model fit the data marginally poorer than the unconstrained model, supporting moderation, $\Delta\chi^2(1) = 3.58$, $p = .06$. Therefore, the unconstrained model was retained.

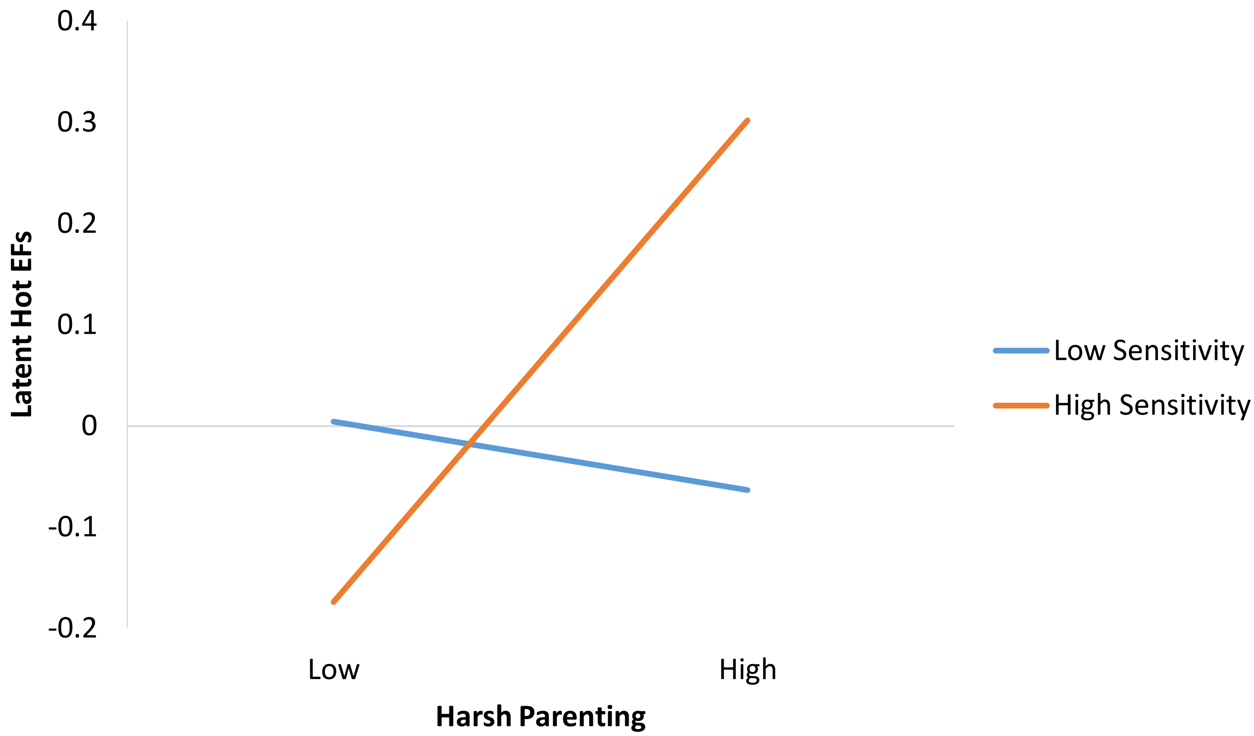
The final model is illustrated in Figure 3. In the final model, harsh parenting significantly predicted cool EFs ($b = -.18$, $SE = .09$, $p = .04$) accounting for 21% of the variability in task performance. Consistent with the findings from the previous research question, harsher parenting was associated with poorer cool EF performance in children. Sensitive parenting did not predict cool EFs ($b = -.05$, $SE = .05$, $p = .32$). The interaction between sensitive parenting and harsh parenting had a marginally significant effect on hot EFs ($b = .03$, $SE = .02$, $p = .06$) accounting for 19% of the variability in hot EF scores. This interaction was interpreted by examining the effect of harsh parenting at different levels of parental sensitivity, as illustrated in Figure 4. Contrary to my prediction, sensitive parenting amplified the effect of harsh parenting on children's hot EFs. For children whose mothers were lower in sensitivity, there was no apparent effect of harsh parenting on hot EFs. However, for children whose mothers were higher in sensitivity, there was an effect of harsh parenting, such that children with harsh parents performed better on the hot EF tasks.

Figure 3



Path diagram illustrating the effect of the interaction between sensitive and harsh parenting on cool and hot EFs. Unstandardized (standardized) parameters are presented; error variances and factor loadings for the indicators of cool and hot EFs are not shown. $^{+}p < .10$; $*p < .05$; $**p < .01$.

Figure 4



The effect of harsh parenting on hot EFs by maternal sensitivity. Scores on the parenting measures were mean centered. Low harsh parenting corresponded to a score of -1.31 (the lowest possible score, .71 standard deviations below the mean) while high harsh parenting corresponded to a score of 3.15 (1 standard deviation above the mean). Low and high sensitivity were equal to -2.99 and 2.99, 1 standard deviation below and above the mean score, respectively.

Discussion

This study provided the first concurrent analysis of the relative contributions and interactive effects of sensitive and harsh parenting in predicting children's cool and hot EF abilities. First, this study examined if and how maternal sensitivity and harshness affected children's cool and hot EFs. I hypothesized that both sensitive and harsh parenting would be associated with cool EFs. Only harsh parenting significantly predicted children's cool EF skills, partially supporting this hypothesis. Neither sensitive nor harsh parenting independently predicted children's hot EF abilities. Second, the interactive effect of sensitive and harsh parenting on cool and hot EFs was examined. I hypothesized that sensitive parenting would moderate the effect of harsh parenting on hot EFs, but not cool EFs, such that sensitive parenting would buffer the negative effect of harsh parenting on children's hot EFs. Results partially supported this hypothesis. The interaction between sensitive and harsh parenting was marginally significant for hot EFs and not significant for cool EFs, consistent with predictions. However, the interaction did not take the hypothesized form. Instead of buffering the negative effect of harsh parenting on children's hot EFs, high sensitivity parenting was associated with a positive correlation between harsh parenting and hot EFs.

As hypothesized, the present study found a link between harsh parenting and children's cool EFs. This finding adds to our understanding of how harsh parenting is associated with children's cool EFs across diverse levels of socioeconomic risk. Previous research has found an association between harsh parenting and cool EFs in children raised in low income households (C. Blair et al., 2011; Rhoades et al., 2011). However, harsh parenting has been proposed to act synergistically with other risk factors (e.g., parental conflict) seen in the context of socioeconomic risk (Schonberg & Shaw, 2007); thus, amplifying the negative effect of harsh parenting on cool EFs (Rochette & Bernier, 2014). Therefore, it is unclear if the link between harsh parenting and children's cool EFs is found when socioeconomic risk is reduced. The limited research on this subject is conflicting with one study finding that harsh parenting predicted poorer cool EFs in preschoolers (Cuevas et al., 2014) and the other finding no link between harsh parenting and cool EFs (Rochette & Bernier, 2014). Thus, this study provides additional support for the robustness of the effect of harsh parenting on cool EFs.

The lack of an association between sensitive parenting and children's cool EFs was unexpected. This finding conflicts with previous research on parenting and cool EFs which has consistently found an association between these two variables (e.g., Bernier et al., 2012; Hughes & Ensor, 2005; Roskam et al., 2014). Several factors might explain the contrast between the present findings and the broader literature. First, the majority of previous research has explored the effects of sensitive parenting on cool EFs without controlling for the effects of correlated domains of parenting known to affect children's EFs (e.g., Kraybill & Bell, 2013; Rochette & Bernier, 2014; Towe-Goodman et al., 2014). Harsh parenting, which was included simultaneously in this study, is one such correlated domain of parenting. The inclusion of this measure may have contributed to the discrepancy between the present findings and previous findings. In support of this notion, a growing number of studies suggest that the effect of sensitive parenting on cool EFs becomes non-significant when controlling for the effects of other domains of parenting (Bernier et al., 2012, 2010; Hughes & Ensor, 2009). For example, autonomy support has been found to account for the effect of sensitive parenting on children's cool EFs (Bernier et al., 2010). This suggests that perhaps sensitive parenting is not associated with cool EFs when examined in the context of multiple domains of parenting. The inclusion of one versus multiple measures of parenting likely helps explain the mixed findings.

Second, the contrast between the present findings and the broader literature may have to do with the socioeconomic backgrounds of the populations studied. The only other studies examining the simultaneous effects of sensitive and harsh parenting on cool EFs have found that sensitive parenting makes an independent contribution to cool EFs (C. Blair et al., 2011; Rhoades et al., 2011). The current study differs from these studies in terms of sample characteristics and this may account for the conflicting findings across studies. C. Blair et al. (2011) and Rhoades et al., (2011) used a sample of children whose parents lived below the poverty line. In the current study, the majority of families (58%) lived above the poverty line. There is greater variability in parenting in low income households as compared to middle and high income households (Fish et al., 2004; Vaughn, Egeland, Sroufe, & Waters, 1979). Consistent with this notion, a study on the differential effects of parenting on child development in families that were "poor" (living below the poverty line) and "near-poor" (had incomes less than three times the poverty line) found lower scores and greater variability in maternal sensitivity among the parents in the poor families than near-poor families (Razza, Martin, & Brooks-Gunn, 2010). This study is demographically similar to the current study in which 93% of families had incomes less than three times the value of the poverty line. Thus, it is possible that the present study failed to find an association between parental sensitivity and cool EFs because there was little meaningful variability in the sensitive parenting measure.

What might be driving the negative relation between harsh parenting and children's cool EFs? Two factors that have been proposed to account for this association include differences in language exposure and parental scaffolding. Language is important for the development of higher order cognitive functions, including EFs (Luria, 1961; Vygotsky, 1962). Children with harsh parents are typically exposed to fewer and poorer quality language learning experiences which negatively impacts their language development (Pungello, Iruka, Dotterer, Mills-Koonce, & Reznick, 2009; Raviv, Kessenich, & Morrison, 2004). These differences in language development predict poorer EF abilities in children (e.g., Hammond et al., 2012). In support of this proposed pathway, children's language ability has been found to mediate the effect of sensitive and harsh parenting on cool EFs (Hughes & Ensor, 2009; Matte-Gagné & Bernier, 2011).

A second potential mechanism is parental scaffolding, a robust predictor of children's EFs. Children whose parents engage in more scaffolding behaviours during parent-child interactions perform better on EF tasks (Bibok, Carpendale, & Müller, 2009; Hammond et al., 2012; Hughes & Ensor, 2009). It has been proposed that the use of harsh parenting strategies provides parents with fewer opportunities for teaching children successful strategies to self-regulate their behaviour (Eisenberg et al., 2005; Grusec & Davidov, 2010). For example, harsh parenting is characterized by non-contingent responses to children during interactions; whereas sensitive parenting is characterized by the ability to contingently shift strategies in this context (Carr & Pike, 2012). Hence, harsh parenting may impact children's cool EFs because the strategies that make up harsh parenting preclude parental scaffolding of children's acquisition of strategies that promote self-regulation.

Because language exposure and scaffolding are interconnected, it is unlikely that the unique roles of language and scaffolding in the relation between harsh parenting and children's cool EFs can be established. Language exposure and scaffolding covary (Dieterich, Assel, Swank, Smith, & Landry, 2006). Parents who use more verbal scaffolding provide their children with a more complex language environment than parents who use less verbal scaffolding (Bibok et al., 2009; Dieterich et al., 2006). Thus, it may be impossible to disentangle the contributions of language and scaffolding in the relation between harsh parenting and cognitive development.

The present study found that for higher-sensitivity parents, there was a positive effect of harsh parenting on children's hot EFs. This finding was counterintuitive, and one possible reason for this finding may be the age of the participants in this study. Research on the interactive effects of harsh and sensitive parenting has been predominantly carried out in children that were older than the ones in the present study (e.g., adolescents; Simons et al., 2000). Some researchers suggest that the negative effect of harsh parenting emerges as children age with harsh parenting having a positive effect on early socio-emotional and cognitive development (Landry, Smith, Swank, & Miller-Loncar, 2000; Straus & Mouradian, 1998; Straus, Sugarman, & Giles-Sims, 1997; Talwar et al., 2011). This is because harsh parenting is thought to meet young children's considerable need for direction and structure from their parents promoting development in early chilhood but detrimentally impacting children's later attempts to develop autonomy leading to reduced cognitive and socio-emotional competencies as children age (Landry, Smith, Miller-Loncar, & Swank, 1998; Landry et al., 2000). Consistent with this argument, Landry et al. (2000) found that between the ages of 2 and 3.5, harsh parenting had a positive influence on children's ability to carry out goal-directed behaviours, but by 3.5 years it had a negative effect on this ability. A similar pattern of results has been found for hot EFs, with teacher's use of physical discipline having a positive influence on this ability at age 4 and a negative effect at age 6 (Talwar et al., 2011). Taken together, these findings suggest that the counterintuitive interaction between sensitive and harsh parenting found in the present study may have occurred because participants were at an age when harsh parenting had a positive effect on hot EFs. It remains to be seen if the form of the interaction reported here changes over time with prolonged exposure to harsh parenting. A study of older preschoolers or kindergarten children might find different results.

The argument that harsh parenting leads to improved hot EFs in preschoolers raises the question of if better hot EFs at this age are actually adaptive. Harsh parenting promotes passive compliance and this undermines children's autonomy (Crockenberg & Litman, 1990). As such, children who perform better on hot EF tasks in early childhood are likely not learning how to assert themselves in age appropriate ways. For example, children who are passively compliant as preschoolers are less likely to initiate goal-directed behaviours and social interactions in kindergarten (Kuczynski & Kochanska, 1990; Landry et al., 2000). As children's autonomy is implicated in socio-emotional (Gagne, 2003) and cognitive development (Grolnick & Ryan, 1989), it is likely that improved performance on hot EF tasks in early childhood is maladaptive. It comes with the trade-off of impeding the learning necessary for the acquisition of later competencies.

It is unclear why harsh parenting would differentially affect hot and cool EFs in 3 year old children. One possible explanation for this finding may be that the hot and cool EF tasks differed in their levels of external control. Self-regulation is characterized by the ability to control one's behaviour in the absence of external sources of control (e.g., an individual monitoring performance) (Kopp, 1982). In the hot EF tasks there were greater external pressures to control behaviour relative to the cool EF tasks. For example, in the *Goody Shelf* task, children were explicitly told not to touch the toys, the experimenter monitored children's performance, and the experimenter reinforced the rules if the child broke them. Thus, hot EF tasks may be more highly correlated with children's compliance than cool EF tasks (Wakschlag et al., 2008). Children with harsh parents would be expected to perform better on tasks assessing compliance

(Talwar et al., 2011). Similarly, the reduced levels of external support in cool EF tasks has led to the suggestion that cool EF tasks are more highly correlated with children's ability to initiate and sustain goal directed behaviours than hot EF tasks (Landry et al., 2000). Because harsh parenting is associated with lower autonomy in children, children with harsh parents would be expected to perform worse on tasks assessing cool EFs (Landry et al., 2000). Thus, differences in task demands may be contributing to the pattern of results found in this study.

Findings from the current study should be interpreted in light of the study's limitations. First, observational parenting measures were not available at earlier waves. This necessitated that the analyses for this study be cross-sectional instead of longitudinal. The relation between parenting and children's EFs is transactional (C. Blair, Raver, & Berry, 2014). Children with better EFs elicit more sensitive behaviours from their caregivers, while children with poorer EFs elicit harsher parenting behaviours reinforcing individual differences in EFs (C. Blair et al., 2014). Because this study is cross-sectional, it is possible that children's EFs are driving the observed relations with parenting. A longitudinal design would make it possible to control for the effect of children's prior EFs on current EFs and parenting.

Second, the construct of hot EFs was narrowly defined in this study. The three indicators of hot EFs came from two tasks that were similar in their requirements for delayed gratification, suppression of approach behaviours, and engagement in less appealing alternative behaviours (Wiebe et al., 2015). Although one previous study found a distinction between cool and hot EFs using hot EF tasks similar to the ones used here (Willoughby et al., 2011), another study using tasks that involved a salient reward but not a delay found that cool and hot EFs loaded onto one factor (Allan & Lonigan, 2011). As there is still little research on the factor structure of hot EFs in early childhood, more work is needed to separate the relative contributions of reward, delay, and emotion to hot EFs; this would enable a better examination of relations between hot EFs and parenting.

Third, this study had a relatively small sample for latent variable analyses. The 36 month follow-up sample used here only included the Nebraska subset of the original cohort. Post hoc power analyses using Monte Carlo simulations in MPlus found that the present study had 80% power to detect a true effect of parenting on latent EFs with a magnitude of 0.26 standard deviations, a small effect size. However, it is worth noting that this study's sample size of 144 mother-child dyads was large relative to many studies examining the effects of parenting on children's EFs, which typically have included between 50 and 100 participants (e.g., Bernier et al., 2012, 2010; Hammond et al., 2012).

Fourth, the measures of sensitive and harsh parenting had questionable internal consistency. This suggests one of two things. First, it suggests that these measures might not have adequately assessed the constructs of interest, making it hard to definitely say that it was sensitive and harsh parenting driving the effects found in this study. However, other studies report similar internal consistencies, particular for harsh parenting (e.g., McFadden & Tamis-Lemonda, 2013) which is likely to have low internal consistency because there is little variance in the scores for each item making up the measure. Second, questionable internal consistency suggests that sensitive and harsh parenting may be heterogeneous constructs meaning that sensitive and harsh parents do not act in the same way. For instance, some harsh parents may be high in negative affect while others are over controlling (McFadden & Tamis-Lemonda, 2013). This implies that the constructs of sensitive and harsh parenting can be broken down further.

Fifth, this study only included measures of maternal behaviour and did not assess paternal behaviour. Maternal and paternal behaviours have been found to differentially impact children's

EF development (Karreman, van Tuijl, van Aken, & Dekovic, 2008; Roskam et al., 2014; Towe-Goodman et al., 2014). For example, father's use of negative discipline strategies but not positive discipline strategies was predictive of worse hot EFs in 3 year old children while the opposite pattern of results was found for mothers (Karreman et al., 2008). Furthermore, there is some suggestion that having a sensitive father protects against the detrimental impact of a low sensitivity mother on children's socio-emotional development (Feldman, 2012). Thus, the inclusion of measures of paternal behaviour is important for developing a fuller understanding of the roles of parents in the development of children's EFs.

The present study raises multiple questions that should be addressed in future research. The mechanisms whereby EFs are impacted by parenting remain unclear. It has been argued that parenting affects children's attentional control with differences in attention driving the observed effects on cool and hot EFs (Garon et al., 2008; Pollak, 2012; Rothbart, Derryberry, & Posner, 1994). For example, children who are better able to divert their attention away from a controlling parent outperform children who are worse at diverting their attention in the same situation on hot EF tasks (Sethi, Mischel, Aber, Shoda, & Rodriguez, 2000). As attention is often argued to underlie EF abilities (Johansson, Marciszko, Gredebäck, Nyström, & Bohlin, 2015), this may suggest that parenting does not directly impact cool and hot EFs *per se*, but rather parenting may impact the abilities underlying EFs.

Future research should also explore the possibility that maternal EFs are driving the effect of parenting on children's EFs. Emerging evidence suggests that maternal cool EFs predict care-giving behaviours (Deater-Deckard, Wang, Chen, & Bell, 2012). For example, mothers with poorer EFs are more likely to provide chaotic home environments and engage in harsher parenting practices (Deater-Deckard et al., 2012) which detrimentally affect children's cool EF abilities (Hughes & Ensor, 2009). This suggests a role for maternal EFs in the relation between parenting and children's EFs. Additionally, cool EFs are highly heritable (Friedman et al., 2008) suggesting that the relations between maternal EFs, parenting, and children's EFs may be genetically driven. Further research exploring the possibility that maternal EFs, via the environment or genetics, are contributing to the effect of parenting on children's EFs would contribute to our understanding of the mechanisms involved in this relation.

Furthermore, the measures of sensitive and harsh parenting used in the present study were multidimensional constructs making it difficult to ascertain what specific aspects of parenting underpin the findings. For example, the measure of harsh parenting included negative discipline strategies, negative affect, and power-assertive control and each of these has been linked to poorer EFs in children (C. Blair et al., 2011; Houck & Lecuyer-Maus, 2004; Karreman, van Tuijl, van Aken, & Deković, 2006). As the P-COS only included one to two items from each subcomponent of sensitive and harsh parenting (e.g., power struggles was the only item assessing power-assertive control), it was not possible to look at what precisely underlay the present findings. Future research examining the impact of specific components of sensitivity and harshness on EFs will help give us a more nuanced understanding of how parenting affects the development of children's EFs and the mechanisms involved in these relations.

The present study contributes to our understanding of how specific dimensions of parenting differentially relate to hot and cool EFs in early childhood. Specifically, harsh parenting is linked to poorer cool EFs, whereas parental sensitivity moderates the link between harsh parenting and hot EFs. These results are important because early childhood is when stable individual differences in EFs first emerge (Carlson et al., 2004) and become predictive of long term outcomes like academic performance and psychological adjustment (Shoda et al., 1990). As such, parenting has a critical role in supporting or compromising children's developing EF skills, and therefore may be a fruitful target for intervention.

References

Allan, N. P., & Lonigan, C. J. (2011). Examining the dimensionality of effortful control in preschool children and its relation to academic and socioemotional indicators. *Developmental Psychology*, *47*(4), 905–915.

Baumrind, D. (1991). Parenting style and adolescent development. In R. Lerne, A. Petersen, & J. Brooks-Gunn (Eds.), *Encyclopedia of adolescence: Vol. 2* (pp. 746–758). New York, NY: Garland Publishing.

Bernier, A., Beauchamp, M. H., Carlson, S. M., & Lalonde, G. (2015). A secure base from which to regulate: Attachment security in toddlerhood as a predictor of executive functioning at school entry. *Developmental Psychology*, *51*(9), 1177–1189.

Bernier, A., Carlson, S. M., Deschênes, M., & Matte-Gagné, C. (2012). Social factors in the development of early executive functioning: A closer look at the caregiving environment. *Developmental Science*, *15*(1), 12–24.

Bernier, A., Carlson, S. M., & Whipple, N. (2010). From external regulation to self-regulation: Early parenting precursors of young children's executive functioning. *Child Development*, *81*(1), 326–339.

Bibok, M. B., Carpendale, J. I. M., & Müller, U. (2009). Parental scaffolding and the development of executive function. *New Directions for Child and Adolescent Development*, (123), 17–34.

Blair, C. (2002). School readiness: Integrating cognition and emotion in a neurobiological conceptualization of children's functioning at school entry. *American Psychologist*, *57*(2), 111–127.

Blair, C., Granger, D. A., Willoughby, M., Mills-Koonce, R., Cox, M., Greenberg, M. T., …

Fortunato, C. K. (2011). Salivary cortisol mediates effects of poverty and parenting on executive functions in early childhood. *Child Development*, *82*(6), 1970–1984.

Blair, C., & Raver, C. C. (2012). Child development in the context of adversity: Experiential canalization of brain and behavior. *American Psychologist*, *67*(4), 309–318.

Blair, C., Raver, C. C., & Berry, D. J. (2014). Two approaches to estimating the effect of parenting on the development of executive function in early childhood. *Developmental Psychology*, *50*(2), 554–65.

Blair, C., & Razza, R. P. (2007). Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in kindergarten. *Child Development*, *78*(2), 647–663.

Blair, K. A., Denham, S. A., Kochanoff, A., & Whipple, B. (2004). Playing it cool: Temperament, emotion regulation, and social behavior in preschoolers. *Journal of School Psychology*, *42*(6), 419–443.

Brock, L. L., Rimm-Kaufman, S. E., Nathanson, L., & Grimm, K. J. (2009). The contributions of "hot" and "cool" executive function to children's academic achievement, learning-related behaviors, and engagement in kindergarten. *Early Childhood Research Quarterly*, *24*(3), 337–349.

Campbell, S. (1997). Behavior problems in preschool children: Developmental and family issues. *Advances in Clinical Child Psychology*, *19*, 1–26.

Carlson, S. M., Mandell, D. J., & Williams, L. (2004). Executive function and theory of mind: Stability and prediction from ages 2 to 3. *Developmental Psychology*, *40*(6), 1105–1122.

Carlson, S. M., & Wang, T. S. (2007). Inhibitory control and emotion regulation in preschool children. *Cognitive Development*, *22*(4), 489–510.

Carr, A., & Pike, A. (2012). Maternal scaffolding behavior: Links with parenting style and maternal education. *Developmental Psychology*, *48*(2), 543–551.

Castellanos, F. X., Sonuga-Barke, E. J. S., Milham, M. P., & Tannock, R. (2006). Characterizing cognition in ADHD: Beyond executive dysfunction. *Trends in Cognitive Sciences*, *10*(3), 117–124.

Clark, C. A. C., Sheffield, T. D., Chevalier, N., Nelson, J. M., Wiebe, S. A., & Espy, K. A. (2013). Charting early trajectories of executive control with the Shape School. *Developmental Psychology*, *49*(8), 1481–1493.

Crockenberg, S., & Litman, C. (1990). Autonomy as competence in 2-year-olds: Maternal correlates of child defiance, compliance, and self-assertion. *Developmental Psychology*, *26*(6), 961–971.

Cuevas, K., Deater-Deckard, K., Kim-Spoon, J., Watson, A. J., Morasch, K. C., & Bell, M. A. (2014). What's mom got to do with it? Contributions of maternal executive function and caregiving to the development of executive function across early childhood. *Developmental Science*, *17*(2), 224–238.

Damasio, A. R. (1994). *Descartes' Error: Emotion, reason, and the human brain*. New York, NY: Avon Books.

Darling, N., & Steinberg, L. (1993). Parenting style as context: An integrative model. *Psychological Bulletin*.

Deater-Deckard, K., Ivy, L., & Petrill, S. A. (2006). Maternal warmth moderates the link between physical punishment and child externalizing problems: A parent-offspring behavior genetic analysis. *Parenting*, *6*(1), 59–78.

Deater-Deckard, K., Wang, Z., Chen, N., & Bell, M. A. (2012). Maternal executive function, harsh parenting, and child conduct problems. *Journal of Child Psychology and Psychiatry*, *53*(10), 1084–1091.

Diamond, A., & Goldman-Rakic, P. S. (1989). Comparison of human infants and rhesus monkeys on Piaget's AB task: Evidence for dependence on dorsolateral prefrontal cortex. *Experimental Brain Research*, *74*(1), 24–40.

Dieterich, S. E., Assel, M. A., Swank, P., Smith, K. E., & Landry, S. H. (2006). The impact of early maternal verbal scaffolding and child language abilities on later decoding and reading comprehension skills. *Journal of School Psychology*, *43*(6), 481–494.

Dunn, L. M., & Dunn, D. M. (2007). *Parenting style as context: An integrative model.* Bloomington, IN: NCS Pearson, Inc.

Eisenberg, N., Zhou, Q., Spinrad, T. L., Valiente, C., Fabes, R. A., & Liew, J. (2005). Relations among positive parenting, children's effortful control, and externalizing problems: A three-wave longitudinal study. *Child Development*, *76*(5), 1055–1071.

Espy, K. A. (1997). The Shape School: Assessing executive function in preschool children. *Developmental Neuropsychology*, *13*(4), 495–499.

Espy, K. A., Fang, H., Johnson, C., Stopp, C., Wiebe, S. A., & Respass, J. (2011). Prenatal tobacco exposure: Developmental outcomes in the neonatal period. *Developmental Psychology*, *47*(1), 153–169.

Espy, K. A., Kaufmann, P. M., McDiarmid, M. D., & Glisky, M. L. (1999). Executive functioning in preschool children: Performance on A-not-B and other delayed response format tasks. *Brain and Cognition*, *41*(2), 178–199.

Feldman, R. (2012). Bio-behavioral synchrony: A model for integrating biological and microsocial behavioral processes in the study of parenting. *Parenting*, *12*, 154–164.

Fish, E. W., Shahrokh, D., Bagot, R., Caldji, C., Bredy, T., Szyf, M., & Meaney, M. J. (2004). Epigenetic programming of stress responses through variations in maternal care. *Annals of the New York Academy of Sciences*, *1036*, 167–180.

Friedman, N. P., Miyake, A., Young, S. E., Defries, J. C., Corley, R. P., & Hewitt, J. K. (2008). Individual differences in executive functions are almost entirely genetic in origin. *Journal of Experimental Psychology*, *137*(2), 201–225.

Gagne, M. (2003). The role of autonomy support and autonomy orientation in prosocial behavior engagement. *Motivation and Emotion*, *27*(3), 199–223.

Garon, N., Bryson, S. E., & Smith, I. M. (2008). Executive function in preschoolers: A review using an integrative framework. *Psychological Bulletin*, *134*(1), 31–60.

Goldman, P. S., Rosvold, H. E., Vest, B., & Galkin, T. W. (1971). Analysis of the delayed-alternation deficit produced by dorsolateral prefrontal lesions in the rhesus monkey. *Journal of Comparative and Physiological Psychology*, *77*(2), 212–20.

Grolnick, W. S., & Ryan, R. M. (1989). Parent styles associated with children's self-regulation and competence in school. *Journal of Educational Psychology*, *81*(2), 143–154.

Grusec, J. E., & Davidov, M. (2010). Integrating different perspectives on socialization theory and research: A domain-specific approach. *Child Development*, *81*(3), 687–709.

Grusec, J. E., & Goodnow, J. J. (1994). Impact of parental discipline methods on the child's internalization of values: A reconceptualization of current points of view. *Developmental Psychology*, *30*(1), 4–19.

Hammond, S. I., Müller, U., Carpendale, J. I. M., Bibok, M. B., & Liebermann-Finestone, D. P. (2012). The effects of parental scaffolding on preschoolers' executive function. *Developmental Psychology*, *48*(1), 271–281.

Hill, C., Maskowitz, K., Danis, B., & Wakschlag, L. (2008). Validation of a clinically sensitive, observational coding system for parenting behaviors: The Parenting Clinical Observation Schedule. *Parenting*, *8*(2), 153–185.

Hobson, C. W., Scott, S., & Rubia, K. (2011). Investigation of cool and hot executive function in ODD/CD independently of ADHD. *Journal of Child Psychology and Psychiatry*, *52*(10), 1035–1043.

Hongwanishkul, D., Happaney, K. R., Lee, W. S. C., & Zelazo, P. D. (2005). Assessment of hot and cool executive function in young children: Age-related changes and individual differences. *Developmental Neuropsychology*, *28*(2), 617–44.

Houck, G. M., & Lecuyer-Maus, E. A. (2004). Maternal limit setting during toddlerhood, delay of gratification, and behavior problems at age five. *Infant Mental Health Journal*, *25*(1), 28–46.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, *6*(1), 1–55.

Hughes, C. (1998). Executive function in preschoolers: Links with theory of mind and verbal ability. *British Journal of Developmental Psychology*, *16*(2), 233–253.

Hughes, C., Dunn, J., & White, A. (1998). Trick or treat?: Uneven understanding of mind and emotion and executive dysfunction in “hard-to-manage” preschoolers. *Journal of Child Psychology and Psychiatry*, *39*(7), 981–994.

Hughes, C., & Ensor, R. A. (2005). Executive function and theory of mind in 2 year olds: A family affair? *Developmental Neuropsychology*, *28*(2), 645–668.

Hughes, C., & Ensor, R. A. (2009). How do families help or hinder the emergence of early executive function? *New Directions for Child and Adolescent Development*, 123, 35–50.

Jacobsen, T., Huss, M., Fendrich, M., Kruesi, M. J. P., & Ziegenhain, U. (1997). Children's ability to delay gratification: Longitudinal relations to mother-child attachment. *The Journal of Genetic Psychology*, *158*, 411–426.

Johansson, M., Marciszko, C., Gredebäck, G., Nyström, P., & Bohlin, G. (2015). Sustained attention in infancy as a longitudinal predictor of self-regulatory functions. *Infant Behavior & Development*, *41*, 1–11.

Johnson, M. H. (1995). The inhibition of automatic saccades in early infancy. *Developmental Psychobiology*, *28*(5), 281–291.

Karreman, A., van Tuijl, C., van Aken, M. A. G., & Dekovic, M. (2008). Parenting, coparenting, and effortful control in preschoolers. *Journal of Family Psychology*, *22*(1), 30–40.

Karreman, A., van Tuijl, C., van Aken, M. A. G., & Deković, M. (2006). Parenting and self-regulation in preschoolers: A meta-analysis. *Infant and Child Development*, *15*(6), 561–579.

Kim, S., Nordling, J. K., Yoon, J. E., Boldt, L. J., & Kochanska, G. (2013). Effortful control in "hot" and "cool" tasks differentially predicts children's behavior problems and academic performance. *Journal of Abnormal Child Psychology*, *41*(1), 43–56.

Kline, R. B. (2011). *Principles and Practice of Structural Equation Modeling* (3rd ed.). New York, NY: Guilford Press.

Kochanska, G., Murray, K., Jacques, T. Y., Koenig, A. L., & Vandegeest, K. A. (1996). Inhibitory control in young children and its role in emerging internalization. *Child Development*, *67*(2), 490–507.

Kochanska, G., Murray, K. T., & Harlan, E. T. (2000). Effortful control in early childhood: Continuity and change, antecedents, and implications for social development. *Developmental Psychology*, *36*(2), 220–232.

Kopp, C. B. (1982). Antecedents of self-regulation: A developmental perspective. *Developmental Psychology*, *18*(2), 199–214.

Kraybill, J. H., & Bell, M. A. (2013). Infancy predictors of preschool and post-kindergarten executive function. *Developmental Psychobiology*, *55*(5), 530–538.

Kuczynski, L., & Kochanska, G. (1990). Development of children's noncompliance strategies from toddlerhood to age 5. *Developmental Psychology*, *26*(3), 398–408.

Landry, S. H., Smith, K. E., Miller-Loncar, C. L., & Swank, P. R. (1998). The relation of change in maternal interactive styles to the developing social competence of full-term and preterm children. *Child Development*, *69*(1), 105–123.

Landry, S. H., Smith, K. E., Swank, P. R., & Miller-Loncar, C. L. (2000). Early maternal and child influences on children's later independent cognitive and social functioning. *Child Development*, *71*(2), 358–375.

Li-Grining, C. P. (2007). Effortful control among low-income preschoolers in three cities: Stability, change, and individual differences. *Developmental Psychology*, *43*(1), 208–221.

Luria, A. R. (1961). *The role of speech in the regulation of normal and abnormal behavior*. New York, NY: Liveright.

Mattanah, J. F., Pratt, M. W., Cowan, P. A., & Cowan, C. P. (2005). Authoritative parenting, parental scaffolding of long-division mathematics, and children's academic competence in fourth grade. *Journal of Applied Developmental Psychology*, *26*(1), 85–106.

Matte-Gagné, C., & Bernier, A. (2011). Prospective relations between maternal autonomy support and child executive functioning: Investigating the mediating role of child language ability. *Journal of Experimental Child Psychology*, *110*(4), 611–625.

McFadden, K. E., & Tamis-Lemonda, C. S. (2013). Maternal responsiveness, intrusiveness, and negativity during play with infants: Contextual associations and infant cognitive status in a low-income smaple. *Infant Mental Health Journal*, *34*(1), 80–92.

McIntyre, L. L., Blacher, J., & Baker, B. L. (2006). The transition to school: Adaptation in young children with and without intellectual disability. *Journal of Intellectual Disability Research*, *50*(5), 349–361.

McLoyd, V. C. (1998). Socioeconomic disadvantage and child development. *American Psychologist*, *53*(2), 185–204.

McLoyd, V. C., & Smith, J. (2002). Physical discipline and behavior problems in African American, European American, and Hispanic children: Emotional support as a moderator. *Journal of Marriage and the Family*, *64*(1), 40–53.

Merz, E. C., Landry, S. H., Williams, J. M., Barnes, M. A., Eisenberg, N., Spinrad, T. L., … Consortium, the S. R. R. (2014). Associations among parental education, home environment quality, effortful control, and preacademic knowledge. *Journal of Applied Developmental Psychology*, *35*(4), 304–315.

Mischel, W., Shoda, Y., & Rodriguez, M. L. (1989). Delay of gratification in children. *Science*, *244*(4907), 933–938.

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology*, *41*(1), 49–100.

Moriguchi, Y., & Hiraki, K. (2009). Neural origin of cognitive shifting in young children. *Proceedings of the National Academy of Sciences*, *106*(14), 6017–6021.

Muthén, L. K., & Muthén, B. O. (2012). *Mplus User's Guide* (7th ed.). Los Angeles, CA: Muthén & Muthén.

Nelson, C. A., & Bloom, F. E. (1997). Child development and neuroscience. *Child Development*, *68*(5), 970–987.

Nelson, C. A., Thomas, K. M., & De Haan, M. (2006). Neural bases of cognitive development. In W. Damon & R. M. Lerner (Eds.), *Handbook of Child Psychology*. Hoboken, NJ: Wiley and Sons Inc.

Paus, T., Zijdenbos, A., Worsley, K., Collins, D. L., Blumenthal, J., Giedd, J. N., … Evans, A. C. (1999). Structural maturation of neural pathways in children and adolescents: In vivo study. *Science*, *283*(5409), 1908–11.

Pollak, S. D. (2012). The role of parenting in the emergence of human emotion: New approaches to the old nature-nurture debate. *Parenting*, *12*(2-3), 232–242.

Pungello, E. P., Iruka, I. U., Dotterer, A. M., Mills-Koonce, R., & Reznick, J. S. (2009). The effects of socioeconomic status, race, and parenting on language development in early childhood. *Developmental Psychology*, *45*(2), 544–557.

Raver, C. C. (2004). Placing emotional self-regulation in sociocultural and socioeconomic contexts. *Child Development*, *75*(2), 346–353.

Raviv, T., Kessenich, M., & Morrison, F. J. (2004). A mediational model of the association between socioeconomic status and three-year-old language abilities: The role of parenting factors. *Early Childhood Research Quarterly*, *19*(4), 528–547.

Razza, R. A., Martin, A., & Brooks-Gunn, J. (2010). Associations among family environment, sustained attention, and school readiness for low-income children. *Developmental Psychology*, *46*(6), 1528–42.

Razza, R. A., & Raymond, K. (2013). Associations among maternal behavior, delay of gratification, and school readiness across the early childhood years. *Social Development*, *22*(1), 180–196.

Rhoades, B. L., Greenberg, M. T., Lanza, S. T., & Blair, C. (2011). Demographic and familial predictors of early executive function development: Contribution of a person-centered perspective. *Journal of Experimental Child Psychology*, *108*(3), 638–662.

Rochette, É., & Bernier, A. (2014). Parenting, family socioeconomic status, and child executive functioning: A longitudinal study. *Merrill-Palmer Quarterly*, *60*(4), 431–460.

Rohner, R. P., & Britner, P. A. (2002). Worldwide mental health correlates of parental acceptance-rejection: Review of cross-cultural and intracultural evidence. *Cross-Cultural Research*, *36*(1), 16–47.

Roskam, I., Stievenart, M., Meunier, J.-C., & Noël, M.-P. (2014). The development of children's inhibition: Does parenting matter? *Journal of Experimental Child Psychology*, *122*, 166–

Rothbart, M. K., Derryberry, D., & Posner, M. I. (1994). A psychobiological approach to the development of temperament. In J. E. Bates & T. D. Wachs (Eds.), *Temperament: Individual differences at the interface of biology and behavior.* (pp. 83–113). Washington, DC: American Psychological Association.

Rubia, K. (2011). "Cool" inferior frontostriatal dysfunction in dysfunction in conduct disorder: A review. *Biological Psychiatry*, *69*(12), 69–87.

Schonberg, M. A., & Shaw, D. S. (2007). Do the predictors of child conduct problems vary by high- and low-levels of socioeconomic and neighborhood risk? *Clinical Child and Family Psychology Review*, *10*(2), 101–136.

Séguin, J., Nagin, D., Assaad, J.-M., & Tremblay, R. E. (2004). Cognitive-neuropsychological function in chronic physical aggression and hyperactivity. *Journal of Abnormal Psychology*, *113*(4), 603–613.

Sethi, A., Mischel, W., Aber, J. L., Shoda, Y., & Rodriguez, M. L. (2000). The role of strategic attention deployment in development of self-regulation: Predicting preschoolers' delay of gratification from mother-toddler interactions. *Developmental Psychology*, *36*(6), 767–777.

Shaw, P., Kabani, N. J., Lerch, J. P., Eckstrand, K., Lenroot, R., Gogtay, N., … Wise, S. P. (2008). Neurodevelopmental trajectories of the human cerebral cortex. *Journal of Neuroscience*, *28*(14), 3586–3594.

Shoda, Y., Mischel, W., & Peake, P. K. (1990). Predicting adolescent cognitive and self-regulatory competencies from preschool delay of gratification: Identifying diagnostic conditions. *Developmental Psychology*, *26*(6), 978–986.

Simons, R. L., Wu, C., Lin, K.-H., Gordon, L., & Conger, R. D. (2000). A cross-cultural examination of the link between corporal punishment and adolescent antisocial behavior. *Criminology*, *38*(1), 47–80.

Simpson, A., & Riggs, K. J. (2006). Conditions under which children experience inhibitory difficulty with a "button-press" go/no-go task. *Journal of Experimental Child Psychology*, *94*, 18–26.

Sokol, B. W., & Müller, U. (2007). The development of self-regulation: Toward the integration of cognition and emotion. *Cognitive Development*, *22*(4), 401–405.

Stanislaw, H., & Todorov, N. (1999). Calculation of signal detection theory measures. *Behavior Research Methods, Instruments, & Computers*, *31*(1), 137–149.

Straus, M. A., & Mouradian, V. E. (1998). Impulsive corporal punishment by mothers and antisocial behavior and impulsiveness of children. *Behavioral Sciences and the Law*, *16*(3), 353–374.

Straus, M. A., Sugarman, D. B., & Giles-Sims, J. (1997). Spanking by parents and subsequent antisocial behaviour in children. *Archives of General Psychiatry*, *151*, 761–767.

Talwar, V., Carlson, S. M., & Lee, K. (2011). Effects of a punitive environment on children's executive functioning: A natural experiment. *Social Development*, *20*(4), 805–824.

Toplak, M. E., Jain, U., & Tannock, R. (2005). Executive and motivational processes in adolescents with Attention-Deficit-Hyperactivity Disorder (ADHD). *Behavioral and Brain Functions*, *1*(8).

Towe-Goodman, N. R., Willoughby, M., Blair, C., Gustafsson, H. C., Mills-Koonce, W. R., & Cox, M. J. (2014). Fathers' sensitive parenting and the development of early executive functioning. *Journal of Family Psychology*, *28*(6), 867–876.

Vaughn, B., Egeland, B., Sroufe, L. A., & Waters, E. (1979). Individual differences in infant-mother attachment at twelve and eighteen months: Stability and change in families under stress. *Child Development*, *50*(4), 971–975.

Vitaro, F., Brendgen, M., Larose, S., & Tremblay, R. E. (2005). Kindergarten disruptive behaviors, protective factors, and educational achievement by early adulthood. *Journal of Educational Psychology*, *97*(4), 617–629. http://doi.org/10.1037/0022-0663.97.4.617

Vygotsky, L. S. (1962). *Thought and language*. Cambridge, MA: MIT Press.

Wakschlag, L. S., Hill, C., Carter, A. S., Danis, B., Egger, H. L., Keenan, K., … Briggs-Gowan, M. J. (2008). Observational assessment of preschool disruptive behavior. Part I: Reliability of the Disruptive Behavior Diagnostic Observation Schedule (DB-DOS). *Journal of the American Academy of Child and Adolescent Psychiatry*, *47*(6), 622–631.

Wakschlag, L. S., Hill, C., Danis, B., Grace, D., & Keenan, K. (2013). *Parenting Clinical Observation Schedule (P-COS) for coding parent behaviour during DB-DOS parent context (unpublished manual)*.

Wiebe, S. A., Clark, C. A. C., De Jong, D. M., Chevalier, N., Espy, K. A., & Wakschlag, L. (2015). Prenatal tobacco exposure and self-regulation in early childhood: Implications for developmental psychopathology. *Development and Psychopathology*, *27*(02), 397–409.

Wiebe, S. A., Sheffield, T. D., & Espy, K. A. (2012). Separating the fish from the sharks: A longitudinal study of preschool response inhibition. *Child Development*, *83*(4), 1245–1261.

Wiebe, S. A., Sheffield, T., Nelson, J. M., Clark, C. A. C., Chevalier, N., & Espy, K. A. (2011). The structure of executive function in 3-year-olds. *Journal of Experimental Child Psychology*, *108*(3), 436–452.

Willoughby, M., Kupersmidt, J., Voegler-Lee, M., & Bryant, D. (2011). Contributions of hot and cool self-regulation to preschool disruptive behavior and academic achievement. *Developmental Neuropsychology*, *36*(2), 162–180.

Woodcock, R. W., McGrew, K. S., & Mather, N. (2001). *Woodcock Johnson III Tests of Cognitive Abilities*. Rolling Meadows, IL: Riverside Publishing.

Zeanah, C., Larrieu, J., Heller, S., & Valliere, J. (2000). Infant-parent relationship assessment. In C. Zeanah (Ed.), *Handbook of infant mental health* (pp. 222–235). New York, NY: Guilford Press.

Zelazo, P. D., & Carlson, S. M. (2012). Hot and cool executive function in childhood and adolescence: Development and plasticity. *Child Development Perspectives*, *6*(4), 354–360.

Zelazo, P. D., & Cunningham, W. A. (2007). Executive function: Mechanisms underlying emotion regulation. In J. J. Gross (Ed.), *Handbook of emotion regulation* (pp. 135–158). New York, NY: Guildford Press.

Zelazo, P. D., & Muller, U. (2011). Executive function in typical and atypical development. In U. Goswami (Ed.), *The Wiley-Blackwell handbook of childhood cognitive development* (2nd ed., pp. 574–603).

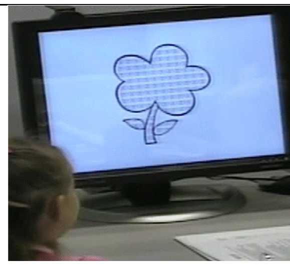
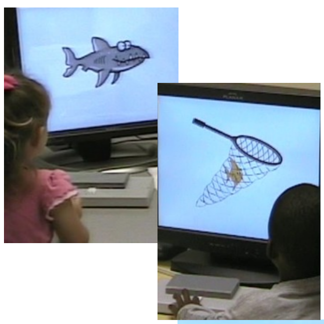
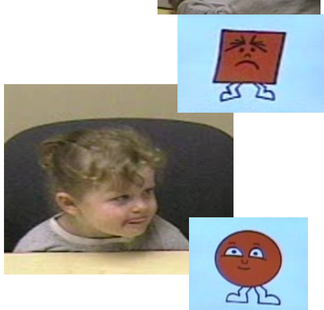
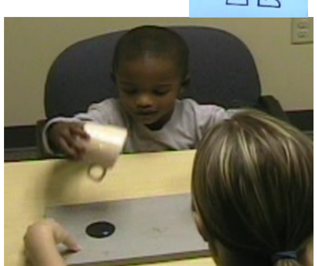
Zelazo, P. D., Müller, U., Frye, D., Marcovitch, S., Argitis, G., Boseovski, J., … Carlson, S. M. (2003). The development of executive function in early childhood. *Monographs of the Society for Research in Child Development*, *68*(3), 1–151.

Zhou, Q., Hofer, C., Eisenberg, N., Reiser, M., Spinrad, T. L., & Fabes, R. A. (2007). The developmental trajectories of attention focusing, attentional and behavioral persistence, and externalizing problems during school age years. *Developmental Psychology*, *43*(2), 369–385.

Appendix 1: Reliability and validity for the EFs battery

Table 1

Illustrations, reliability, and validity information for measures of cool and hot EFs

Measure	Illustration	Reliability	Validity
	Cool EFs		
Big-Little Stroop		Test-retest reliability: $\kappa = .74$ (Kochanska et al., 2000).	Construct validity: $r = .45$ for a battery of 6 effortful control tasks, including this task, with the inhibition subscale of the Child Behaviour Questionnaire (Kochanska et al., 2000).
Go/No-Go		No information available.	Construct validity: $r = .68$ with the Day Night task (Simpson & Riggs, 2006).
Shape School (inhibition)		Internal consistency: $\alpha = .71$ (Espy et al., 2006).	Construct validity: $r = .19 – .25$ with the Digit Span task and Visual Attention task from the NEPSY (Espy et al., 2006).
Delayed Alternation		No information available.	Construct validity: factor loading of .79 with A-not-B task (Espy et al., 1999).
Nebraska Barnyard		No information available.	Construct validity: factor loadings of -.03 to -.34 with measures of inhibition and set shifting (Hughes, 1998).

Hot EFs			
Snack Delay		Test-retest reliability: $r = .59$ for a battery of 7 inhibitory control tasks, including Snack Delay (Kochanska et al., 1996).	Construct validity: $r = .30 – .42$ for the test battery with the inhibition subscale of the Child Behaviour Questionnaire (Kochanska et al., 1996).
Goody Shelf		No information available.	Construct validity: $r = .37–.41$ with Snack Delay measures (Wiebe et al., 2015).

Adapted from Wiebe et al. (2015).

Appendix 2: Description of P-COS subscales

Table 1

Descriptions and examples for each item included in the measures of sensitive and harsh parenting

Item	Description	Example
	Sensitivity	
Scaffolding	Parental behaviours designed to help the child be successful, respect the child's autonomy, and reflect the parent's ability to understand the child's developmental level, abilities, and cues.	Parent organizes puzzle pieces before the child starts the puzzle.
Responsivity to Positive Behaviours	Parent provides positive feedback in response to child compliance or performance.	"Thank you" in response to compliance with a directive.
Warm Affection	Physical behaviour and verbal statements which express affection and warmth toward the child.	Parent hugs their child.
Positive Engagement	A measure of a) the level of positive parental engagement with the child and b) parental behaviours indicating that the parent takes pleasure in the shared experience.	Parent smiles while engaging with their child.
Labelling	Behaviours that demonstrate a) that the parent is able to read the social cues of the child and b) is able to verbally express that which the child's behaviours are communicating.	"I know you're unhappy" in response to the child frowning.
Intensity of Positive Affect	The highest level of positive affect exhibited by the parent.	Bouts of laughter.
Pervasiveness of Positive Affect	The presence and consistency of positive affect throughout all four tasks.	Positive affect is present multiple times but it does not predominate across tasks.

	Harshness	
Hostile Behaviours	Parental behaviours that are spiteful or nasty, including statements intended to be rejecting, critical, or provoke the child's anger.	Parent tells child, "You're not smart enough to finish that."
Verbally Aggressive Discipline	The use of verbal threats to use physical discipline or cursing at the child.	Parent says "Don't make me spank you."
Physical Discipline	The use of threatening gestures, mildly aggressive behaviours (e.g., rough handling), or physical discipline.	Parent threatens to take their belt off.
Power Struggles	Parental behaviours that descend to the child's level and are designed primarily to win rather than manage the child's behaviour.	Child says "Go away" and parent responds by saying "No you go away."
Emotional Misattunement	Parental behaviours that reinforce and escalate the child's negative affect.	"Mutual anger" between the parent and child, such as when the child yells and the parent yells back in response.
Intensity of Angry/Irritable Affect	The highest level of angry/irritable affect exhibited by the parent.	Glares, yelling.
Pervasiveness of Angry/Irritable Affect	The presence and consistency of angry/irritable affect throughout the tasks.	Parent displays negative affect during one task, but in the remaining tasks, angry/irritable affect does not predominate.

Adapted from Wakschlag, Hill, Danis, Grace, and Keenan (2013).