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GENETIC AND CONTEXTUAL DETERMINANTS OF EARLY-EMERGING EFFORTFUL CONTROL

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GENETIC AND CONTEXTUAL DETERMINANTS OF EARLY-EMERGING EFFORTFUL CONTROL

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Abstract

Effortful control (EC) has important implications for children's development. Although genetic factors and parenting have been shown to influence EC, few studies have examined whether they interact to predict its development. The current study investigated associations between parenting and children's EC, and whether these associations were moderated by children's *DRD4* exon III VNTR genotype. A community sample of 409 three-year-olds completed behavioural measures of EC, and their caregivers completed laboratory and self-report measures of parenting. Observed and self-reported negative parenting were associated with lower child EC. The association between children's EC and positive parenting was moderated by children's *DRD4* genotype, such that children with at least one 7-repeat allele displayed both better and poorer EC than children without this allele, depending on the degree of positive parenting. These results extend recent findings suggesting that certain genetic polymorphisms sensitize children to contextual influences in a bivalent manner.

Keywords: effortful control, dopamine D4 receptor, parenting

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Genetic and Contextual Determinants of Early-Emerging Effortful Control

From an early age, children exhibit variability in their reactions to similar contexts. For example, when encountering an unfamiliar person or situation, some children show interest, positive affect, and engagement. In contrast, others react with fear, and may attempt to hide or withdraw. Individual differences in emotions and behaviors such as these are called temperament. Traditionally, descriptions of temperament were primarily concerned with differences in biologically driven patterns of behavior, which were considered largely involuntary (e.g., Buss & Plomin, 1984). More recent theories of temperament, however, incorporate a regulatory component, suggesting that individuals are able to exert voluntary control over reactive tendencies, and factor analyses of relevant data have provided empirical support for such models. For example, Rothbart, Ahadi, Hershey and Fisher (2001) reported data supporting a three-factor solution of child temperament. The first dimension, which included traits such as high intensity pleasure, activity level, impulsivity and low levels of shyness, was labelled extraversion/surgency. The second dimension, called negative affectivity, included traits such as sadness, discomfort, anger/frustration, fear and poor soothability. Critical to the present discussion, Rothbart and colleagues described a third temperament dimension which they referred to as effortful control, which is responsible for the voluntary regulation of reactive emotions and behavior.

Effortful control (EC) is defined as the "ability to inhibit a dominant response in order to engage in a subdominant response" (Rothbart, Ellis, Rueda & Posner, 2003, p. 1114). EC allows individuals to focus and shift attention, to choose a course of action when presented with conflicting options, to suppress responses not consistent with a plan of

action and to perceive errors (Rothbart, 2007). Importantly, EC is not only involved in the inhibition of dominant responses but also in the activation of non-dominant responses. For example, EC is needed to inhibit impulsive behavior in order to achieve long terms rewards, and also to motivate participation in rewarding activities despite experiencing fear, anxiety or boredom (Rothbart, 1989; Sansone, Wiebe, & Morgan, 1999; Kieras, Tobin, Graziano, & Rothbart, 2005; Rick, Cryder, & Loewenstein, 2008). EC emerges near the end of the first year of life, demonstrating particularly rapid development in the preschool years, and continues to mature throughout early childhood and into adolescence (Kochanska, Murray & Harlan, 2000). Despite this ongoing growth, the rank order of EC remains relatively stable throughout toddlerhood and into the early school years. (Kochanska & Knaack, 2003).

EC overlaps substantially with several near-neighbour constructs, particularly executive functioning. Executive functions are a broad set of complex cognitive processes that are necessary for flexible, goal-directed behavior (Hughes & Graham, 2002). As such, the cognitive processes required for EC are considered a subset of executive functions, although methods of measuring the two constructs overlap substantially and the terms are often used interchangeably. Importantly, while tests of executive functioning, such as traditional versions of the Stroop task, are intended to be affectively and contextually neutral, measures of EC typically are not (Blair & Razza, 2007). For example, in the executive functioning literature, inhibitory control is defined as the capacity to immediately and completely cease an ongoing behavior or thought (Williams, Ponesse, Schachar, Logan & Tannock, 1999). In contrast, in the EC literature, inhibitory control is defined as the ability to suppress an impulsive response in accordance with

instruction or social cues (Carlson & Moses, 2001). Thus, EC, and inhibitory control in particular, are thought to be a function of the emotional or motivational context as well as individual differences in regulatory capacities. Given that many behaviors that might benefit from regulation do not occur in an affectively neutral context, EC may be of greater relevance to important social and psychological outcomes than executive functioning. Hence, the focus of the present research is on EC although the literature on executive functioning and other related constructs is drawn upon as necessary.

In support of its relevance to meaningful outcomes, EC is an important predictor of prosocial emotions and conscience. For example, Eisenberg, Wentzel and Harris (1998) proposed that children's EC would be associated with the capacity to express sympathy, and consistent with this hypothesis, teacher reports of EC were related to parent and teacher reported sympathy when measured concurrently (Eisenberg, et al., 1996). Similarly, in a cross-sectional study Rothbart, Derryberry, and Posner (1994) found that children high in EC demonstrated greater empathy and guilt, and less aggressive behavior, than those low in EC. Kochanska, Murray and Coy (1997) demonstrated that EC was positively related to conscience in toddlers, preschoolers and early school-aged children when measured concurrently. Furthermore, when examined longitudinally, laboratory measures of EC predicted children's conscience at early school age.

Considering its role in prosocial emotions, it is unsurprising that EC is also of particular importance for social development. Heatherton and Vohs (1998) argued that self-regulation, a concept closely related to EC, is vital to forming and maintaining successful dyadic and group relationships, proposing that individuals who are better able to internalize and adhere to societal rules are less likely to be socially rejected. In other

words, self-regulation allows individuals to overcome self-serving impulses in favour of pro-social behavior, which in turn leads to greater social inclusion (Vohs & Ciarocco, 2004). Consistent with this hypothesis, children with greater EC also demonstrated more socially appropriate behaviors and were given higher status ratings by their peers (Eisenberg, Fabes, Guthrie, & Reiser, 2000). Similarly, Raver, Blackburn, Bancroft and Torp (1999) found that children who were able to inhibit the desire to touch an attractive toy were rated by their teachers as being more socially competent and were described as more popular and less rejected by their peers, compared to children lower in inhibitory control. Furthermore, teacher reports of EC were positively correlated with peer and teacher reports of agreeableness, which included ratings of kindness, generosity, cooperation, and warmth (Cumberland-Li, Eisenberg, & Reiser, 2004). EC is also positively related to prosocial behaviors. Eisenberg and colleagues (1996) found that boys rated high on regulation by their parents and teachers were more frequently nominated by their peers as someone who would help out without being asked to do so.

In addition to having implications for social development, EC is also relevant to psychopathology risk. Deficits in EC have been consistently associated with the presence and development of externalizing disorders, a class of disorders characterized by impulsive, poorly controlled behavior (e.g., attention deficit/hyperactivity disorder; Eisenberg, Smith, Sadovsky & Spinrad, 2004). Lemery, Essex and Smider (2002) found that maternal reports of inhibitory control were negatively correlated with parent reports of externalizing problems and symptoms of attention deficit hyperactivity disorder. Similarly, Eisenberg and colleagues (2001) found that maternal reports of externalizing problems were related to observed and maternal reports of EC. More compelling evidence

for the role of EC in the pathogenesis of externalizing psychopathology comes from research showing that EC is a prospective predictor of externalizing problems. Kochanska and Knaack (2003) found that EC, assessed by a battery of laboratory tasks at 22 months, was negatively related to maternal reports of externalizing behaviors at 73 months, and Eisenberg and colleagues (2009) demonstrated that changes in EC over time were negatively related to changes in externalizing symptoms. In contrast, the association between EC and internalizing disorders (i.e., depressive and anxiety disorders) is more complex. Some researchers propose that deficits in EC are related to internalizing disorders (e.g., Lemery, Essex & Snider, 2002) whereas others suggest that excessively high EC is related to internalizing symptoms (e.g., Murray & Kochanska, 2002).

Recently, Carver, Johnson and Joormann (2008) described a more complex relationship between EC and internalizing and externalizing disorders than previously described in the literature, building on Gray's (1987) biopsychological theory of emotion. In their model, Carver et al. (2008) propose that there are two modes of self-regulation. The first mode is reactive and reflexive, acting on existing contextual cues in order to facilitate rapid responding. This reactive system is composed of two competing temperamental sub-traits that regulate reward and punishment sensitivity, respectively. In contrast to this reactive mode, the second mode, EC, is more reflective and controlled, resulting in slower but more deliberate processing that incorporates the consideration of long-term objectives. Hence, in a given situation, an individual's general predisposition toward approach or avoidance is tempered by EC, with the two interacting to determine behavioral outcomes. According to Carver and colleagues, psychopathology results from deficits in EC that impair the ability to temper these reactive processes. For example,

individuals with strong reward sensitivity who are deficient in the EC needed to successfully modulate these tendencies are at risk for externalizing disorders. In contrast, those high in punishment sensitivity who lack the EC needed to override these tendencies when appropriate are more likely to display internalizing symptoms. In this model, therefore, EC is viewed as a vital regulatory force that moderates the association between temperamental reactivity and psychopathological outcomes.

Thus, the available literature indicates that EC plays a key role in shaping important outcomes of childhood, whether it is through the direct effects of EC on socialization and negative mental health outcomes or through the moderation of other traits that influence vulnerability to psychopathology. Thus, understanding its early origins could have implications for preventative strategies. With respect to how individual differences in EC arise, biological theories of temperament posit that temperamental variation reflects individual differences in neuroanatomy and neurophysiology (e.g., Gray, 1990; Posner & Rothbart, 2000), which suggests the potential importance of genetic influences on temperament traits, including EC. Consistent with this idea, twin studies suggest a strong genetic influence on EC, with heritability estimates ranging from 43 – 79% (Goldsmith, Buss, Lemery, 1997; Mullineaux, Deater-Deckard, Petrill, Thompson & DeThrone, 2009; Yamagata et al., 2005). EC is thought to be supported by network of brain regions called the executive attention network (Rothbart et al., 1994); consequently, individual differences in EC are often defined as variations in the efficiency of the executive attention network (Posner & Fan, 2005). This network, which involves the anterior cingulate cortex (ACC) and the lateral prefrontal cortex (PFC), is likely required for executive attention tasks such as the regulation of sensory and motor regions, and the

resolution of conflict between different brain regions and competing stimuli (Paus, 2001; Rueda, Posner, & Rothbart, 2004). Consistent with this hypothesis, tasks that produce conflict between competing stimuli and require the inhibition of a dominant response often increase activation in these brain regions (Posner & Fan, 2005). Located on the medial surface of the frontal lobes and encircling the corpus callosum, the ACC has numerous projections to the motor cortex, thus facilitating its control of sensory, cognitive and emotionally-motivated behavior (Banfield, Wyland, Macrae, Munte, & Heatherton, 2004).

Posner and Fan (2005) argue that the executive attention network is modulated by the neurotransmitter dopamine. Several areas of research support this notion. First, brain areas associated with executive attention receive strong projections from the ventral tegmental area, a dopamine-rich region. Second, the cingulate is especially rich in dopamine innervations (Berger, Gaspar, Verney, 1991; Descarries, Lemay, Doucet, & Berger, 1987; Paus, 2001) and dopamine receptors, particularly the dopamine D4 receptor, are densely populated in this region (Boy et al., 1998). Finally, injection of dopamine antagonists, which block dopamine receptors, inhibits performance on tasks requiring executive attention, and dopamine depletion in the dorsal lateral prefrontal cortex impairs performance on executive attention tasks (Nieoullon, 2002). Thus, it is clear that dopamine plays an important role in the executive attention network and in EC.

The dopamine D4 receptor (*DRD4*) gene has been most consistently related to measures of attention, and its polymorphic variants are thought to have direct biochemical implications for attention by promoting synchronized firing of neuronal networks (Deth, Kuznetsova, Waly, 2004). Found on chromosome 11p15, *DRD4* codes for a receptor

protein located, in varying amounts, on neuronal membranes throughout the brain. Binding of dopamine to this receptor initiates a number of biochemical cascades, one of which inhibits accumulation of cyclic adenosine monophosphate, a molecule required for a wide variety of biochemical processes (see Neve, Seamans & Trantham-Davidson, 2004). The *DRD4* gene is highly polymorphic (Wang et al., 2004), and has a variable number tandem repeat (VNTR) located in the third exon that codes for the third intracellular loop of the resulting receptor protein. The number of tandem repeats varies across individuals from two to eleven repeats, with 2-, 4- and 7- repeats being the most frequent variants in Caucasians (Ding et al., 2002). The 7-repeat variant exhibits decreased signal transduction efficiency relative to the 4-repeat variant (Asghari et al., 1995), and may also have decreased RNA stability or translational efficiency (Schoots & Van Tol, 2003). Furthermore, there are robust differences between receptor variants in folding efficiency when shaping the final protein product, such that the mRNA transcript of the *DRD4* 2-repeat allele folds more quickly into a protein product than the transcripts of longer alleles, thus increasing *DRD4* transmission (van Craenenbroeck et al., 2005). Cumulatively, these effects are likely to have a significant impact on the signalling and functioning of neural circuits involved in EC.

In addition to the observed biochemical effects of the various *DRD4* exon III VNTR variants, genetic associations further support the role of these variants in EC. First, several meta-analyses suggest that the 7-repeat allele is associated with symptoms of attention deficit hyperactivity disorder (e.g., Faraone, Doyle, Mick, & Biederman, 2001; Li, Sham, Owen & He, 2006; Maher, Marazita, Ferrell, & Vanyukov, 2002). The 7-repeat allele is also associated with attention deficits in non-clinical samples of infants and preschoolers

(Auerbach, Benjamin, Faroy, Geller, & Ebstein, 2001; Schmidt, Fox, Perez-Edgar, Hu, & Hamer, 2001). Individuals with the 7-repeat allele also demonstrate poorer inhibitory control (Congdon, Lesch, & Canli, 2008) and increased aggression (Schmidt, Fox, Rubin, Hu, & Hamer, 2002). However, this literature has not been consistent. For example, Kramer and colleagues (2009) linked the 7-repeat allele to increased cognitive ability and greater inhibitory control. Similarly, Fossella and colleagues (2002) found that the 4-repeat allele, rather than the 7-repeat allele, was related to deficits in executive attention (see also Swanson et al., 2001). Thus, despite evidence suggesting that *DRD4* exon III VNTR polymorphic variants are related to EC, the exact nature of the relationship remains unclear.

The inconsistencies in the genetics literature suggest that additional factors may be relevant to the development of EC. Despite large genetic contributions, EC is also shaped by social experiences, primarily parenting (Campos, Campos & Barrett, 1989; Gottman et al, 1997; Karreman, van Tuijl, van Aken, & Dekovic, 2006). Positive and negative parenting practices could potentially influence EC through a variety of mechanisms (Valiente et al., 2006; Eisenberg et al., 2005). For example, Hoffman (2000) proposed that hostile parenting increases children's negative emotionality, which may hinder children's ability to engage in complex cognitive processes, including those responsible for EC (Blair, 2002). In contrast, parents who provide a warm and nurturing environment likely induce positive emotions in their children by creating a sense of security and stability (Davies & Cummings, 1994). Given that positive emotions enhance cognitive flexibility (Ashby, Isen & Turken, 1999), parenting styles that increase such emotions may facilitate the development of EC. In addition, children experiencing positive

interactions with parents may be more motivated to comply with and internalize parental directions (Dix, 1991, Grusec & Goodnow, 1994). Skilled parents may also model appropriate and successful methods of regulating behavior (Halberstadt, Crisp, & Eaton, 1999). Authoritative parenting, in which children are provided with clearly defined limits and instruction, may promote the internalization of rules and the subsequent capacity of children to act in accordance with these rules (Lengua, Honorado, & Bush, 2007). Furthermore, supportive parenting, in which parents facilitate children's exploration by providing nonintrusive guidance, likely provides children with the appropriate scaffolding on which to develop greater EC (Lengua et al., 2007). Finally, parenting strategies may be a reflection of parents' own EC, suggesting the presence of a passive gene-environment correlation (Rutter, 1997) in which parenting practices and child EC are influenced by the same genetic variants.

Several studies support the notion that parenting influences children's self-regulation and EC. Karremann and colleagues (2008) found that parent self-reported responsiveness and positive control, a construct that includes limit-setting and providing structure, were positively associated with both parent-reports and observations of child EC. Similarly, Lengua and colleagues (2007) found that observed maternal limit-setting, scaffolding, and respect for child autonomy were related to increases in observed EC over a six month period. Maternal self-reports of sensitivity, acceptance and support were positively related to their children's observed EC both concurrently and eleven months later (Kochanska et al., 2000). Self-reported and observer rated maternal expressions of positive emotion were positively associated with their children's regulation, while maternal expressions of negative emotion were negatively associated with EC (Eisenberg et al., 2001). Kochanska

and Knaack (2003) found that observed maternal power assertion, including the use of physical discipline, was a significant predictor of child deficits in EC, and proposed that power assertive parenting behaviors undermined a child's capacity to acquire EC. Therefore, it appears that parenting practices play a significant role in promoting or inhibiting the development of children's EC.

However, it is likely that children vary in their susceptibility to the effects of both positive and negative parenting behaviors (Belsky, Bakermans-Kranenburg, & van Ijzendoorn, 2007, Belsky & Pluess, 2009; Ellis & Boyce, 2008; Ellis, Boyce, Belsky, Bakermans-Kranenburg, & Van Ijzendoorn, 2011; Rutter, Moffit & Caspit, 2006). According to Belsky and colleagues (2009), some genetic variants may not simply confer risk or resilience, but sensitivity to contextual factors, which can result in either positive or negative outcomes depending on the given context. In the case of the *DRD4* gene, parenting may interact with genetic polymorphisms in the *DRD4* exon III VNTR region to influence child behaviors and outcomes, although only a handful of studies have examined this possibility (see Bakermans-Kranenburg & Van Ijzendoorn, 2011). For example, maternal insensitivity assessed at 10 months was associated with greater child externalizing problems at 39 months, but only in those children with the 7-repeat allele of the *DRD4* receptor gene (Bakermans-Kranenburg, & van Ijzendoorn, 2006; however, see Propper, Willoughby, Halpern, Carbone & Cox, 2007 for contradictory results). Similarly, interventions designed to prevent externalizing problems by improving parenting techniques were more effective for children with the 7-repeat allele than those without the 7-repeat allele (Bakermans-Kranenburg, van Ijzendoorn, Pijlman, Mesman, & Juffer, 2008). Maternal unresolved loss or trauma was also associated with disorganized

attachment, but only in infants with a 7-repeat allele (Van Ijzendoorn & Bakermans-Kranenburg, 2006). Together, these results suggest that children with the 7-repeat allele may be particularly sensitive to parental influences, both positive and negative. The potential role of gene-environment interaction would help account for the rather inconsistent findings in the genetic association literature, given that such studies generally fail to account for contextual influences on EC.

To date, empirical investigations of parenting and genetic influences on EC have proceeded largely as independent lines of research, with few exceptions (Sheese, Voelker, Rothbart & Posner, 2007; Smith et al., under review; see also Belsky & Beaver, 2011). Sheese and colleagues (2007) examined the interaction between *DRD4* exon III VNTR polymorphisms and parenting in predicting sensation seeking and EC. Results of the study indicated that lower quality parenting resulted in greater sensation seeking in children with the 7-repeat allele than those without the 7-repeat allele. They failed to find an interaction or main effect of allelic variation in *DRD4* and parenting quality in predicting EC; however, this study was hampered by a small sample size ($N = 45$). Also, participants in this study were 18 to 21 months of age. Since EC does not crystallize until around 3 to 4 years of age, it is possible that estimates of EC in younger populations are subject to greater measurement error than those obtained in older children. Furthermore, researchers aggregated across positive and negative parenting variables to create a single index of parenting quality that was subsequently dichotomized for analyses. Aside from the concern regarding dichotomization of a continuous variable, several papers show differential effects of positive and negative parenting on children's EC, indicating that aggregating across these variables may obscure potentially interesting associations

between parenting and EC (Karreman et al., 2006, Zhou, Eisenberg, Wang & Reiser, 2004). Thus, examining positive and negative parenting separately may reveal associations that global measures of parenting do not. Consistent with this notion, our group (Smith et al., under review) recently reported that negative parenting interacted with children's *DRD4* genotype to predict measures of EC, with findings indicating that children with a 7-repeat of the *DRD4* exhibited significantly poorer EC at higher levels of negative parenting than those without a 7-repeat. While positive parenting showed a bivariate association with child EC in the sample, this effect was no longer significant after accounting for the interaction between negative parenting and *DRD4* genotype.

It is also important to note that Sheese et al. (2007) used parent-reported measures of EC, rather than observational measures. This is not atypical of this literature, as much of the research to date has relied on this approach. However, previous research shows only weak to modest correlations between observational measures and parent reports of child temperament variables, suggesting that the method of measurement may have an important influence on the findings obtained (Durbin, Hayden, Klein, Olino, 2007; Hayden, Durbin, Olino, & Klein, in press; Stifter, Willoughby, & Towe-Goodman, 2008). Parent reports are influenced by an array of factors other than child behavior, such as parent personality, psychopathology and stress (Kagan, 1998; de Los Reyes & Kazdin, 2005), and many parents may lack a sufficient knowledge of developmental norms to rate their own child's behavior accurately. Furthermore, parents may lack the expertise required to distinguish EC from overlapping, yet related constructs. Similar difficulties arise when considering self-reported parenting, which also shows only modest correlations with observational measures (Zaslow et al., 2006).

The current study was designed to address the limitations of extant research on the role of the *DRD4* exon III VNTR polymorphism and parenting in EC. More specifically, by increasing the sample size, incorporating observational measures of EC, and by using more fine-grained measures of parenting, we improved upon and extended the existing literature. Given the substantial evidence that parenting plays an important role in the development of EC, we expected that positive parenting factors, including parent sensitivity, supportive presence, positive affectivity, confidence and authoritative parenting would be associated with greater levels of EC. Furthermore, we expected that negative parenting factors including intrusiveness, hostility, negative affectivity, detachment, authoritarian parenting, and overly indulgent parenting would also be associated with lower levels of child EC. Finally, given evidence that the *DRD4* 7-repeat allele sensitizes children to parenting influences, and based on recent work from our group (Smith et al., under review), we predicted that the relationship between parenting variables and EC would be moderated by *DRD4* exon III VNTR genotype such that the effects of parenting are more pronounced in children with the *DRD4* 7-repeat allele.

We extended our recent work on this topic (Smith et al., under review) through several means. First, both observational and self-reported measures of parenting were tested as moderators of associations between children's *DRD4* genotype and EC. Second, we used a broader range of tasks to elicit parenting in the present study, and parenting assessments were conducted in the homes of participating families. The observational measures of parenting used by Smith et al. (under review) assessed parenting under neutral or low-stress conditions only (i.e., while mothers and their children interacted during quiet play). It is possible that the moderating effect detected in that study could be

strengthened by the use of tasks that elicit a wider range of negative parenting, and by assessing parenting in the home where such interactions might better reflect "typical" parenting. Hence, the present study incorporated an additional task designed to elicit negative parent-child interactions, and the entire parenting assessment took place during a home visit. Third, most research on parenting in general has focused on mother-child relationships, with few studies collecting data on both caregivers. While it was not feasible to collect observational measures of both parents' parenting styles, we collected self-report measures of parenting from both caregivers.

Method

Participants

Four hundred and nine children between 36- and 47-months old ($M = 40.72$, $SD = 3.51$) and their primary ($N = 409$) and secondary caregivers ($N = 381$) were recruited as part of a larger longitudinal study of child personality. Participants were recruited via a developmental database (14%), flyers posted in local preschools (18%), advertisements posted on community websites (21%), friend referral (40%), and other miscellaneous sources (7%). Based on a preliminary telephone screening process, children previously diagnosed with a significant psychological or medical condition were excluded from participation. Depending on family composition, secondary caregivers were not always available (i.e., single parent families; $n = 28$). Primary caregivers were almost always the child's mother (93%) and secondary caregivers were almost always the child's father (90%). The primary caregivers' average age was 33.53 years ($SD = 5.07$), and secondary caregivers' average age was 35.14 ($SD = 5.85$). Family income was measured on a 5-point likert scale and varied widely (5.5% < $20,000; 11% $20,000-$40,000; 22.7% $40,001-

$70,000; 31.2% $70,001-$100,000; 29.5% > $100,001). Children were mostly Caucasian (90%), and of average estimated cognitive ability (M = 111.94, SD = 14.32) as indexed by the Peabody Picture Vocabulary Test-Fourth Edition, a measure of receptive vocabulary (PPVT; Dunn & Dunn, 2007). One hundred percent of the initial 409 families participated in a parenting assessment conducted in the home, which occurred approximately 16 days following the initial lab visit (M =15.85 , SD =8.83).

Laboratory Assessment of EC

Episodes from the Laboratory Temperament Assessment Battery (Lab-TAB; Goldsmith, Reilly, Lemery, Longley, & Prescott, 1995) were used to assess child temperament. In total, children participated in 12 tasks designed to elicit emotion and behavior. Each task was video recorded for future coding, and the entire visit lasted approximately 1.5 – 2 hr. Two of the twelve tasks were used to assess EC and are described below; the other tasks in the battery will not be discussed further here.

Tower of patience. A female experimenter and child took turns building a tower using large cardboard blocks. The experimenter waited a series of increasing delays (5, 10, 15, 20, 30 s) before placing her block on the tower, thus forcing the child to wait increasingly longer periods of time before being given a turn. Two towers were built over the course of the task.

Snack delay. The experimenter placed a chocolate candy underneath a transparent cup, telling the child that (s)he must wait until the experimenter rang a bell before picking up the cup and eating the candy. The experimenter adhered to a series of delays of increasing length (5, 10, 20, 30 s), forcing the child to wait longer each time to eat the candy.

Coding Procedures for EC

As indices of EC, each task was coded for failures to wait (e.g., placing a block out of turn, or eating the candy before the bell was rung). The total number of these behaviors was recorded for each delay (see Appendix A for coding procedures; see Carlson, 2005, Kochanska, Murray, Jacques, Koenig & Vandegeest, 1996, and Kochanska, & Knaack, 2003, for similar procedures). Failures to wait were averaged across each delay and then across tasks to create an aggregate failures scale (Cronbach's α = .74). Each child was coded by a minimum of two independent undergraduate and graduate raters who were blind to child *DRD4* VNTR genotype and parenting measures. Raters were required to reach a minimum intraclass correlation of .80 with a trained "master coder" before coding independently. Once reliability was achieved, periodic reliability checks were conducted on 25% of the recordings (mean ICC snack delay = .93; mean ICC tower of patience = .96).

Observed Parenting

Observed measures of parenting were obtained for 407[1] of the 409 families. The first task was similar to that used by Smith and colleagues (under review), and was designed to elicit parent-child interactions during low-stress circumstances, while the second task was intended to tap parental responses to child behavior within a context that pulled for child misbehavior and non-compliance.

Three bag task. This task was based on a task developed by the National Institute of Child Health and Human Development (1997), modified by Ipsa and colleagues (Ipsa

1 Due to technological difficulties, recordings of two families were unavailable for coding.

et al., 2004). The primary caregiver and their child were instructed to play together with three bags of toys. The first bag contained a book, the second contained a set of toy kitchen items, and the third bag contained a farmhouse play set. The pair was told to play with the toys in order and to put away one set of toys before moving on to the next set. This free play paradigm lasted approximately 10 minutes.

Prohibition task. The primary caregiver and the child were presented with two boxes of toys. The first box contained toys that would be fun or exciting for children in this age group (e.g., a toy electronic guitar). The second box contained unexciting and age-inappropriate toys that were missing pieces or batteries, such as a plastic cone and pieces for Mr. Potato head without the head. Initially, the primary caregiver was instructed to keep his or her child from playing with the appealing toys, thus requiring the caregiver to engage the child in play with the uninteresting toys. After 3 minutes, the primary caregiver was told that they could allow their child to play with the toys in either bin, and after a 6 minute play period, the caregiver was told to have the child put away the toys. The child was then given 5 minutes to tidy up. The experimenter gave instructions to the primary caregiver on printed instruction cards to increase the child's perception that these were the caregiver's commands rather than the experimenter's.

Coding of Parenting Tasks

Video recordings of the in-home parenting tasks were coded by trained graduate and undergraduate raters using a coding manual based on the Teaching Tasks coding manual (Weinfield, Egeland, & Ogawa, 1997) and the Qualitative Ratings for Parent-Child Interactions scale (Cox & Crnic, 2003). Raters were trained to an intraclass correlation of .80 with a master coder. Once interrater reliability was established,

intermittent reliability checks were performed on 15% of all recordings. Coders periodically met and reviewed recordings together to prevent observer drift. Parent-child interaction tasks were coded on a total of 18 Likert scales (see Appendix B). For the purposes of the current study, only eight of these scales were used as the remaining scales were measures of child behavior during the tasks. The selected scales were: parent sensitivity, parent detachment, parent supportive presence, parent intrusiveness, parent hostility, parent confidence, parent positive affectivity, and parent negative affectivity. Interrater ICCs for the three bag task and prohibition task were .86 and .87 respectively.

To reduce the number of observed parenting scales for analyses, observed parenting scales were first averaged across tasks to create eight composite scales. Next, a principal components analysis using oblique rotation was conducted on these eight composites. Results indicated a two-factor solution[2]. The first factor, which accounted for 47.18% of the total variance, included loadings from parent negative affectivity (.81), parent hostility (.79), and parent intrusiveness (.79). This factor was named negative parenting. The second factor, which accounted for 16.79% of the total variance, included loadings from parent supportive presence (.73), parent positive affectivity (.86), parent sensitivity (.70) and negative loadings from parent detachment (-.87). This factor was named positive parenting. In accordance with these findings, two aggregates were then formed by averaging standardized scores for scales that loaded on each factor, one representing positive parenting and the second representing negative parenting. Negatively loading scales were reverse coded before standardizing. The positive and

[2] Principal components analysis using oblique rotation was also conducted separately for each parenting task; results were similar to those presented for the composites (i.e., positive and negative parenting factors with similar scale loadings were derived for each task).

negative parenting aggregates were significantly correlated ($r = -.42, p < .001$). Because negative parenting values were positively skewed, a log10 transformation was applied and transformed values were used in all analyses.

Caregiver Self-reports of Parenting

Caregiver self-reports of parenting were assessed using the short version of the Parenting Styles and Dimensions Questionnaire (PSDQ; Robinson, Mandleco, Olsen & Hart, 2001; see Appendix C). Completed PSDQs were obtained from 405 primary caregivers (99%) and 375 secondary caregivers (98%). This measure has good psychometric properties (Locke & Prinz, 2002; Robinson et al. 1995). Designed for use with preadolescent children, each of the 32 items describes a particular parenting behavior. Caregivers are asked to rate how often he or she exhibits each behavior on a 5-point scale ranging from 1 (never) to 5 (always). Three aggregate scores representing authoritative, authoritarian and indulgent parenting styles are given. According to Baumrind (1971) and Maccoby & Martin (1983), authoritative parenting is characterized by high parental control and responsiveness. In contrast, authoritarian parenting describes a parenting style that is high in control, but low in responsiveness, and indulgent parenting is characterized by high levels of responsiveness, but low control. As indexed by coefficient alpha, internal consistency estimates for these three scales were .84, .76 and .68 respectively. For the secondary caregivers reliability estimates for the three scales were .88, .79, and.68 respectively.

DNA Collection and Genotyping

DNA was collected at the initial laboratory visit from all 409 participants using buccal swabs (Epicentre, Madison, WI, USA), and was extracted by Qiagen DNA

MicroKit® (Mississauga, ON, Canada) according to manufacturer's protocols. DNA was successfully extracted for 394 of the 409 children. The 48-base pair VNTR located in the third exon of the *DRD4* gene was amplified using a 25 µl reaction containing 25 ng of genomic DNA template with forward primer 5'-CGCGACTACGTGGTCTACTCG-3' and reverse primer 5'-AGGACCCTCATGGCCTTG-3', and 1 U of NovaTaq polymerase (Novagen, Gibbstown, New Jersey, USA). The reaction also included 2 mM each of dATP, dCTP and dTTP, 1mM each of dGTP, dITP, with 10% DMSO and 1X PCR amplification buffer (20 mmol/l Tris-HCL pH 8.4, 50 mmol/L KCL). PCR amplification was carried out in a GeneAmp PCR System 9700 (ABI Biosystems, Foster City, California, USA). Following an initial denaturation at 95°C for 5 minutes, thirty cycles of amplification were run with each cycle consisting of denaturation at 95°C for 20 sec, annealing at 54°C for 20 sec, and extension at 72°C for 40 sec, ending with a final extension step of 5 min at 72°C. The PCR amplicons were then resolved on a 2% agarose gel, stained with ethidium bromide (Sigma, Oakville, Ontario, Canada) and documented on the Bio-Rad 1300 Gel documentation system (Mississauga, ON, Canada). Product sizes were determined against a 100 bp molecular weight standard (Invitrogen, Carlsbad, California, USA).

The *DRD4* VNTR polymorphism, like other VNTRs, has many possible variants (Wang et al., 2004), ranging from 2- to 11-repeat copies reported in the literature to date. In our sample, the following genotypes were present: 2/2 (N = 10, 2.4%), 2/4 (N = 67,16.3%), 2/5 (N = 1 ,.2%), 2/7 (N = 8, 2.0%), 2/8 (N = 2, .5%), 3/3 (N = 3, .7%), 3/4 (N = 9, 2.2%), 3/5 (N = 7, 1.7%), 3/7 (N = 2, .5%), 3/11 (N = 1, .2%), 4/4 (N = 157, 38.3%), 4/5 (N = 4, 1.0%), 4/7 (N = 96, 23.4%), 4/8 (N = 3, .7%) 5/5 (N =1, .2%), 7/7 (N = 21,

5.1%), and 7/11 (N = 1, .2%). This genotype distribution is not consistent with Hardy-Weinberg equilibrium (*Pearson* X^2 (45) = 163.31, p <.05; Guo & Thompson, 1992), but is comparable to recently reported frequencies (Ding et al., 2002). All genotyping was performed by research technicians blind to other study data. Consistent with the majority of published research (e.g., Faraone et al., 2001; Sheese et al., 2007), groups for data analysis were formed based on whether children had (N = 128, 32%) or did not have (N = 266, 68%) a 7-repeat allele. These percentages resemble those previously reported in the literature (Ding et al., 2002; Sheese et al., 2007).

Results

Table 1 shows observed and caregiver-reported parenting, children's EC (i.e., failures to wait), and relevant demographic variables broken down by the two *DRD4* genotype groups. The two *DRD4* genotype groups did not differ in total failures to wait, indicating no direct association between this gene and measures of EC. Also, the two genotype groups did not differ on any demographic variables, including gender, age, PPVT and family income. Similarly, the two genotype groups did not differ in observed positive or negative parenting, indicating no direct association between children's *DRD4* genotype and observed measures of the parenting they received. However, primary caregiver-reported authoritarian parenting differed across genotype groups, such that parents of children without a 7-repeat allele reported greater levels of authoritarian parenting than parents of children with a 7-repeat allele. This effect was also weakly evident for secondary caregivers, who differed in authoritarian parenting between the two genotype groups at the level of a trend. Groups based on children's genotypes did not differ on any other primary or secondary caregiver-reported parenting variable.

Table 1. Demographic and study variables by child *DRD4* Exon III VNTR Genotype

	Child *DRD4* Exon III VNTR Genotype					
	7-Repeat Absent (*N*=266)			7-Repeat Present (*N*=128)		
Variable	*M*	*SD*	*N*	*M*	*SD*	*N*
Failures to Wait	.18	.16		.18	.16	
Child Sex (Male)			126 (47%)			67(52%)
PPVT	112.03	14.23		111.62	13.90	
Family Income	3.68	1.13		3.77	1.19	
Child Age (in years)	3.42	.29		3.45	.31	
Observed Positive Parenting	0.01	0.85		-0.02	0.85	
Observed Negative Parenting	0.00	0.16		0.00	0.15	
C1 Authoritative	61.21	6.50		60.87	6.54	
C1 Authoritarian*	19.15	4.34		18.26	3.54	
C1 Indulgent	10.34	2.72		10.18	2.51	
C2Authortative	56.83	8.43		57.38	7.01	
C2 Authoritarian†	20.05	4.92		19.16	4.46	
C2 Indulgent	10.94	2.95		10.70	2.91	

*$p < .05$ †$p < .10$.

Note: PPVT = Peabody Picture Vocabulary Test; C1 = primary caregiver reports; C2 = secondary caregiver reports; Family income coded as 1 = < $20,000; 2= $20,000-$40,000; 3= $40,001-$70,000; 4 = $70,001-$100,000; 5 = > $100,001; Observed positive and observed negative parenting variables were standardized, thus means are approximately zero.

Table 2. Correlations between child EC, observed and caregiver-reported parenting, and demographic variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Failures to wait	-												
2. Observed Negative Parenting	.37***	-											
3. Observed Positive Parenting	-.18***	-.42***	-										
4. C1: Authoritative Parenting	.03	-.04	.17***	-									
5.C1: Authoritarian Parenting	.19***	.25***	-.22***	-.36***	-								
6. C1: Indulgent Parenting	.12*	.17**	-.15**	-.22***	.40***	-							
7. C2: Authoritative Parenting	.06	.02	.10	.25***	-.27***	-.09	-						
8. C2: Authoritarian Parenting	.07	.13*	-.07	-.25***	.46***	.21***	-.41***	-					
9. C2: Indulgent Parenting	.06	.12*	-.03	-.01	.13*	.22***	-.18***	.28***	-				
10. Child Gender	-.23***	.09	-.00	-.09	-.02	.05	-.06	-.02	-.04	-			
11. Child Age	-.23***	-.15	-.03	-.02	-.03	-.11*	-.01	.00	-.16**	.07	-		
12. PPVT Score	-.23***	-.22***	.19***	.12*	-.11*	-.09	.05	-.10	-.04	.05	.05	-	
13. Family income	-.11*	-.13**	.29***	.04	-.15**	-.13**	.07	-.14**	.04	-.02	.06	.10*	-
Mean	.01	.00	.00	61.07	18.87	10.25	57.01	19.79	10.88	-	3.43	111.94	3.73
Standard Deviation	.76	.81	.84	6.44	4.10	2.64	8.00	4.80	2.92	-	.30	14.02	1.14

***$p < .001$, ** $p < .01$, * $p < .05$.

Note: PPVT = Peabody Picture Vocabulary Test, Gender coded as male = 1, female = 2, Family income coded as 1 = < $20,000; 2= $20,000-$40,000; 3= $40,001-$70,000; 4 = $70,001-$100,000; 5 = > $100,001.

Bivariate associations between all other major study variables, excluding *DRD4* genotype, are presented in Table 2. With respect to the associations between children's EC failures and parenting measures, children whose parents engaged in higher levels of observed positive parenting demonstrated fewer EC failures (i.e., fewer failures to wait), while children receiving higher levels of observed negative parenting demonstrated more EC failures (i.e., more failures to wait). This is consistent with previous work supporting associations between parenting and EC (Eisenberg et al., 2005; Kochanska et al., 2000; Lengua et al., 2007; Valiente et al., 2006). Self-reported parenting styles were also associated with children's EC; higher levels of primary caregiver-reported authoritarian parenting behavior were associated with more EC failures. Similarly, primary caregiver-reported indulgent parenting was positively associated with EC failures. In contrast, primary caregiver-reported authoritative parenting was not associated with failures to wait. Secondary caregiver-reports of authoritative, authoritarian and indulgent parenting were also unassociated with children's EC.

With respect to correlations between measures of parenting, observed parenting and caregiver-reported parenting were associated in meaningful ways, albeit at generally modest levels of significance. As we had observational measures of the primary caregiver only, we focus on the relationship between these and the primary caregivers' self-reported parenting here. Observed negative parenting was significantly and positively associated with primary caregiver reports of negative (i.e., authoritarian and indulgent) parenting, but not significantly correlated with authoritative parenting. In contrast, observed positive parenting was significantly and positively correlated with primary caregiver-reported authoritative parenting. Furthermore, observed positive parenting was significantly and

negatively correlated with primary caregiver-reports of authoritarian and indulgent parenting.

Consistent with extant research (Baumrind, 1973; Simons & Conger, 2007), there was also evidence for similarity across caregivers in terms of parenting styles. More specifically, primary caregiver reports of authoritative parenting were significantly and positively correlated with secondary caregiver reports of authoritative parenting. Additionally, primary caregiver reports of authoritarian parenting were significantly and positively associated with secondary caregiver reports of authoritarian parenting. Primary caregiver reports of indulgent parenting were significantly and positively correlated with secondary caregiver reports of indulgent parenting.

In accordance with previously reported findings (e.g., Else-Quest, Hyde, Goldsmith & Van Hulle, 2006), boys demonstrated more failures to wait than girls. PPVT scores were also associated with EC, such that children with higher PPVT scores were less likely to fail to wait. PPVT scores were also related to positive and negative parenting; they were negatively correlated with observed negative parenting and primary caregiver authoritarian parenting, and positively associated with observed positive parenting and primary caregiver authoritative parenting. Child age was negatively associated with failures to wait and with indulgent parenting by primary and secondary caregivers. Finally, family income was negatively correlated with an array of study variables, including EC failures, observed negative parenting, authoritarian parenting by both caregivers, and primary caregivers' indulgent parenting.

Analyses testing *DRD4*-parenting interactions in predicting children's EC

In order to examine whether associations between measures of parenting and

children's EC were moderated by children's *DRD4* exon III VNTR genotype[3], multiple regression was used (Aiken & West, 1991). All predictor variables were centered as needed. *DRD4* genotype was dummy coded such that 0 scores reflected the absence of a 7-repeat, and scores of 1 reflected the presence of a 7-repeat, and product terms reflecting each parenting measure**DRD4* genotype were created. To address the small but significant correlations between EC and child sex, PPVT, child age and family income, all models were initially run treating these as covariates. As results were virtually identical to models run without these covariates, to increase power and to simplify interpretation of model coefficients, we present results without these covariates. Given the documented gender differences in EC, and the potential for cognitive ability to interact with either *DRD4* and/or parenting variables in predicting EC, two-way interactions between child sex and PPVT with *DRD4* and parenting were initially tested; none were significant (all *ps* > .06) and were therefore dropped from final models.

In the first model, observed positive parenting and observed negative parenting aggregated across the two parenting tasks, and child *DRD4* genotype were entered, followed by the products of the two parenting variables with child *DRD4* genotype (i.e., observed positive parenting**DRD4*; observed negative parenting**DRD4*). Neither the main effect, nor the interaction between observed positive parenting aggregated across parenting tasks and *DRD4* was significant in the full model (Table 3). While the main effect of observed negative parenting aggregated across tasks was significant, the interaction between observed negative parenting and *DRD4* was not, indicating that the

[3] To address concerns regarding population stratification, all analyses were run without non-Caucasian participants and treating ethnicity as a covariate. Such analyses yielded virtually identical results to those yielded by the full sample; hence, we retained all participants in findings presented here.

positive relationship between observed negative parenting and failures to wait did not differ based on children's *DRD4* 7-repeat genotype[4].

In the second model, primary and secondary caregiver-reported authoritarian, authoritative and indulgent parenting, and child *DRD4* genotype were entered, followed by the interaction between *DRD4* and each of the caregiver reported variables (Table 4). Only the main effect of primary caregiver-reported authoritarian parenting was significant, though primary caregiver-reported authoritative parenting showed a trend toward significance. None of the interaction terms between *DRD4* genotype and caregiver-reported parenting were significant, indicating that the positive association between primary caregiver-reported authoritarian parenting and failures to wait did not differ based on children's genotype[5].

Since most children in our sample were presumably exposed to the parenting styles of both parents, primary and secondary caregivers' parenting scores were averaged across analogous PDSQ scales to create scores reflecting both parents' parenting styles. In this model, main effects of both average authoritative and average authoritarian parenting on children's EC failures were found, such that both parenting styles were positively associated with failures to wait, but none of the interaction terms were significant (see Table 5).

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[4] The three way interaction between *DRD4*, observed positive parenting and observed negative parenting was also tested, but was non-significant ($p > .30$)

[5] Three way interactions between *DRD4* and self-reported positive and negative parenting within caregiver were also tested, but all were non-significant ($ps > .27$).

Table 3. Children's *DRD4* exon III VNTR genotype, positive and negative observed parenting aggregates and their interaction as predictors of children's failures to wait.

	Overall Model				Change Statistics			
	Df	R^2	*F*	*Cohen's* f^2	*Df*	ΔR^2	ΔF	*B*
Step 1	3,388	.129	19.12***	.15				
DRD4 Genotype								.006
Positive Parenting								-.004
Negative Parenting								.363***
Step 2	5,386	.132	11.73***	.00	2,386	.003	0.70	
DRD4 Genotype								.005
Positive Parenting								.003
Negative Parenting								.358***
DRD4 Genotype X Positive parenting								-.024
DRD4 Genotype X Negative Parenting								-.009

***$p < .001$.

Note: *DRD4* genotype = *DRD4* exon III VNTR status coded as 7-repeat absent = 0, 7-repeat present = 1, Gender coded as male = 1, female = 2.

Table 4. Children's *DRD4* exon III VNTR genotype, primary and secondary caregiver-reported parenting and their interaction as predictors of children's failures to wait.

	Overall Model				Change Statistics			
	Df	R^2	*F*	*Cohen's f²*	*Df*	ΔR^2	ΔF	*B*
Step 1	7,352	.06	2.97**	.06				
DRD4 Genotype								-.001
C1 Authoritarian Parenting								.007**
C1 Authoritative Parenting								.002†
C1 Indulgent Parenting								.003
C2 Authoritarian Parenting								.002
C2 Authoritative Parenting								.002
C2 Indulgent Parenting								.002
Step 2	13,346	.07	1.88*	.01	6,346	.01	0.64	
DRD4 Genotype								-.000
C1 Authoritative Parenting								.003†
C1 Authoritarian Parenting								.007**
C1 Indulgent Parenting								.004
C2 Authoritative Parenting								.002
C2 Authoritarian Parenting								.002
C2 Indulgent Parenting								-.001
DRD4 Genotype X C1 Authoritative Parenting								-.003
DRD4 Genotype X C1 Authoritarian Parenting								.001
DRD4 Genotype X C1 Indulgent Parenting								-.004
DRD4 Genotype X C2 Authoritative Parenting								-.001
DRD4 Genotype X C2 Authoritarian Parenting								.001
DRD4 Genotype X C2 Indulgent Parenting								.009

** $p < .01$, * $p < .05$ †$p < .10$.

Note: *DRD4* genotype = *DRD4* exon III VNTR status coded as 7-repeat absent = 0, 7-repeat present = 1, Gender coded as male = 1, female = 2.

Table 5. Children's *DRD4* exon III VNTR genotype, average caregiver-reported parenting and their interaction as predictors of children's failures to wait.

	Overall Model				Change Statistics			
	Df	R^2	*F*	*Cohen's* f^2	*Df*	ΔR^2	ΔF	*B*
Step 1	4,385	.06	6.04***	.06				
DRD4 Genotype								.014
Avg Authoritative								.005***
Avg Authoritarian								.009***
Avg Indulgent								.005
Step 2	10,379	.07	2.83***	.01	6,379	.01	0.71	
DRD4 Genotype								.014
Avg Authoritative								.005**
Avg Authoritarian								.008*
Avg Indulgent								.002
Avg Authoritative*Avg Authoritarian								.000
Avg Authoritative*Avg Indulgent								.001
Avg Authoritarian*Avg Indulgent								.001
DRD4 Genotype*Avg Authoritative								.001
DRD4 Genotype*Avg Authoritarian								.003
DRD4 Genotype*Avg Indulgent								.008

***$p < .001$, ** $p < .01$, * $p < .05$.

Our previous finding (Smith et al., under review) supported the moderating influence of parenting on the relationship between children's *DRD4* genotype and EC using measures of parenting collected under low-stress conditions. To test whether the failure to replicate this effect was due to differences in the context in which parenting was assessed, we re-ran our model testing the interaction between parenting and *DRD4* genotype using parenting ratings from the three bag task only, as this task more closely approximates that used by Smith and colleagues (under review). Results are shown in Table 6. A significant main effect of observed negative parenting in the three bag task was found, as was a significant interaction between observed positive parenting in the three bag task and child *DRD4* genotype.

To further understand the nature of the interaction, we plotted estimated levels of failures to wait across estimated levels of observed positive parenting in the three bag task for children with and without the 7-repeat allele (adjusted for other variables in the model, see Figure 1). For children with at least one copy of the 7-repeat allele, higher levels of observed positive parenting in this task were significantly associated with fewer failures in EC (b = -.05, SE = .02, p = .02); however, for children without a copy of the 7-repeat allele, observed positive parenting in the three bag task was not significantly associated with EC failures (b = .01, SE = .01, p = .46).

Hayes and Matthes' guidelines (Hayes & Matthes, 2009) were used for testing regions of significance in two-way interactions in multiple linear regression according to the Johnson-Neyman technique (Johnson & Fay, 1950). This procedure uses the asymptotic variances, covariances, and other regression parameters to determine the upper and lower boundaries of the focal predictor variable at which groups representing a multi-

Table 6. Children's *DRD4* exon III VNTR genotype, observed positive and negative parenting in the three bag task and their interaction as predictors of children's failures to wait

	Overall Model				Change Statistics			
	Df	R^2	*F*	*Cohen's f²*	*Df*	ΔR^2	ΔF	*B*
Step 1	3,388	.09	12.62***	.10				
DRD4 Genotype								.006
Positive Parenting								-.006
Negative Parenting								.280***
Step 2	5,386	.10	8.72***	.01	2,386	.01	2.70†	
DRD4 Genotype								.006
Positive Parenting								.009
Negative Parenting								.302***
DRD4 Genotype X Positive parenting								-.055*
DRD4 Genotype X Negative Parenting								-.115

***$p < .001$, * $p < .05$ †$p < .10$

Note: *DRD4* genotype = *DRD4* exon III VNTR status coded as 7-repeat absent = 0, 7-repeat present = 1, Gender coded as male = 1, female = 2.

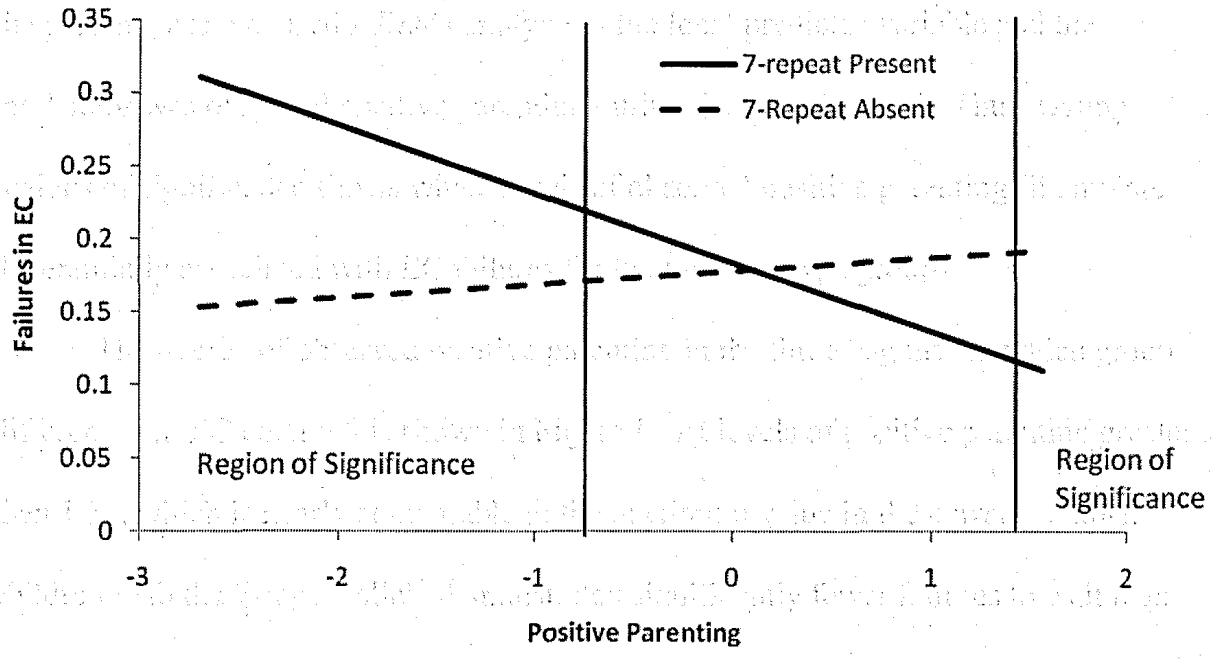

Figure 1. Relationship between observed positive parenting in the three bag task and child EC failures by *DRD4* exon III VNTR genotype.

Note: The lines on the X axis at -.78 and 1.53 derived from the Johnson-Neyman technique (Johnson & Fay, 1950), indicate the values of positive parenting below and above (respectively) which the two *DRD4* genotype groups differ significantly ($p < .05$) in terms of EC failures.

level moderator are significantly different ($p < .05$) in terms of the outcome of interest. In the present case, we used *DRD4* genotype as the focal predictor variable and the moderator was observed positive parenting during the three bag task. Thus, testing regions of significance shows which levels of observed positive parenting (if any) are differentially associated with EC failures for the two genotype groups.

The degree of observed positive parenting in the three bag task at which group differences in EC emerged is shown in Figure 1. At levels of positive parenting greater than 1.53, which is nearly comparable to the maximum value in the current sample, children with the 7-repeat allele demonstrated significantly fewer failures to wait than those without a 7-repeat allele, $t(386) = -1.97$, $p < .05$. Also, at levels of positive parenting below -.78, which is approximately equivalent to one standard deviation below the mean, children with a 7-repeat allele exhibited more failures to wait, $t(386) = 1.97$, $p < .05$. Thus, group differences in EC failures emerged at both relatively high and relatively low levels of positive parenting, which suggests that the 7-repeat of the *DRD4* exon III VNTR sensitizes children to the effects of positive parenting with respect to the development of EC.

Discussion

The current study investigated associations between observed and caregiver-reported parenting and children's EC, and whether these associations were moderated by children's *DRD4* exon III VNTR genotype. Consistent with previous research examining the relationship between parenting and EC (Karreman et al., 2008; Valiente et al., 2006), a main effect of negative parenting behaviors was found across methods, providing strong support for the notion that negative parenting is related to child EC. We found no

evidence that negative parenting was moderated by children's *DRD4* genotype in our sample. However, in a model focusing on observed parenting assessed during a free play task, positive parenting interacted with child *DRD4* genotype to predict EC, such that children with a 7-repeat allele demonstrated both significantly greater and significantly lower EC than children without a 7-repeat allele, depending on the degree of positive parenting. More specifically, children with a 7-repeat allele receiving lower levels of positive parenting showed more failures in EC than children without a 7-repeat allele in a similar parenting environment. In contrast, at higher levels of positive parenting, children with a 7-repeat allele demonstrated fewer failures in EC than children without a 7-repeat allele in similar parenting contexts. These results support recent work from our group indicating that the influence of children's *DRD4* genotypes on emerging EC is moderated by objective measures of parenting (Smith et al., under review). Our findings also serve to support and extend a newly emerging body of literature (e.g., Bakermans-Kranenburg & Van Ijzendoorn, 2011) suggesting that the presence of the 7-repeat allele may sensitize children to the effects of parenting in the development of EC, in a "for-better-and-for-worse manner" (Belsky & Pluess, 2009, p. 12).

We found cross-method negative associations between negative parenting behaviours and children's EC. More specifically, observed negative parenting and primary caregiver-reported authoritarian parenting were associated with more failures to wait, even in models controlling for the effects of other parenting variables. It is important to bear in mind the cross-sectional nature of these associations, which preclude the development of firm conclusions about the direction of the relationship between parenting and children's EC, an issue that is addressed more fully later in this section. However, we

posit that negative parenting could potentially influence children's EC through a variety of mechanisms. For example, parent hostility and negative affect likely induce negative emotions in children, which may impair effective cognitive processing, thus leading to lower child EC (Blair, 2002; Hoffman, 2000; Raver, 1996). Additionally, children's negative emotions may interfere with their ability to contemplate and select appropriate responses and the ability or motivation to internalize socially-dictated rules (Dix, 1991; Grusec & Goodnow, 1994). Furthermore, parents who exhibit negative parenting styles are likely modeling poor inhibitory skills for their children (Halberstadt, Crisp, & Eaton, 1999).

Unexpectedly, regression models showed significant positive links between authoritative parenting averaged across both caregivers and children's EC. This effect was also present at the level of a trend for primary caregiver reports of authoritative parenting. As authoritative parenting is typically believed to promote adaptive child development (Simons & Conger, 2007), the mechanism through which it might influence failures in EC is less clear; however, both authoritative and authoritarian parenting styles consist of high levels of parental control. High levels of parent intrusiveness and control have been demonstrated to reduce children's autonomy which undermines children's ability to learn from experience (Lengua et al., 2007). With respect to why this effect was significant only for authoritative parenting averaged across caregivers, it may be the case that having two caregivers who both engage in high levels of authoritative parenting is less optimal than having only one caregiver who uses such a style, in conjunction with another caregiver who engages in more coercive parenting tactics, at least with respect to children's emerging EC.

Results of our analyses investigating observed parenting during a free play task were supportive of a differential susceptibility model (Belsky & Pluess, 2009; Ellis et al., 2011); tests of regions of significance showed that the two *DRD4* genotype groups differed significantly on EC failures when positive parenting was relatively high and relatively low, with children with a 7-repeat showing significantly fewer and significantly more EC failures respectively than children without a 7-repeat allele. However, these results were not found when observed parenting variables were aggregated across two parent-child interaction tasks, one of which was designed to elicit child misbehavior. The reasons for this discrepancy in findings across tasks are unclear. However, the amount of variance in EC accounted for by negative parenting decreased when including only the free play task in the model, leaving greater variance in EC for the interaction between positive parenting and child *DRD4* genotype to predict.

The observed pattern of results also differs somewhat from our previous finding (Smith et al., under review); while both studies indicate an interaction between children's *DRD4* genotypes and observational measures of parenting, Smith et al. (under review) obtained this effect in the context of negative, not positive, parenting. This could be the result of sampling differences between the two studies. Ellis and colleagues (2011) have posited that restriction in range when assessing contextual variables may impair the ability to detect differential susceptibility. In the present study, participants were a community sample from a relatively affluent and educated area, and negative parenting behaviors were infrequent and relatively mild during observations, thus decreasing the probability of capturing a full range of negative parenting behaviors. The sample used in Smith et al. (under review) may have had greater variability in negative parenting,

although differences in study methods make it difficult to directly test this possibility. In contrast, there is potential for substantial variability in positive parenting behaviors even within affluent, educated families, which may explain why we obtained moderation only for positive parenting in the present sample.

As previously discussed, the modest correlations between parent self-reports and observed measures of parenting suggest that the method of measurement is important in terms of detecting outcomes (Zaslow et al., 2006). Consistent with this notion, the pattern of moderation found for observed positive parenting was not replicated using caregiver-reports of positive parenting. Differences in the use of positive parenting practices are potentially more subtle than the presence or absence of overtly negative behaviors. If observational ratings of positive parenting are simply more accurate than self-reports, this may explain why we found evidence for moderation using one method and not the other. However, it is also possible that conceptual differences between our observed and self-reported measures of parenting may account for these discrepancies. The PSDQ examines authoritative parenting, a construct incorporating high levels of control and responsiveness, but does not incorporate other relevant constructs captured by the observed measures of positive parenting including parental positive affect, which may be particularly relevant for engaging children's dopaminergic reward pathways (Ashby, Isen, Turken, 1999), and thus especially likely to moderate the influence of *DRD4* genotype.

The mechanisms through which positive parenting moderates the influence of the *DRD4* exon III VNTR on children's EC are unknown. However, Belsky and Pluess (2009) and colleagues (Ellis et al., 2011) have speculated that genetic sensitivity to contextual factors may be due to an increased responsiveness to environmental

contingencies for behavior. If correct, polymorphic variants that shape dopaminergic neurotransmission may be particularly important candidates for genetic sensitivity, as dopamine is the primary neurotransmitter involved in neurological pathways of reward (e.g., Robbins & Everitt, 1999; Schultz, 2007), which plays a key role in learning. Positive parenting behaviors may provide an important context of reward that either enhances or mitigates children's genetic predispositions. For example, children with a 7-repeat allele could exhibit greater fluctuations in dopamine levels in response to the rewarding context of high levels of positive parenting or to the absence of such rewards. These dopamine fluctuations result in enhanced development of EC in the context of rewarding parent-child interactions, and relatively impaired development of EC when rewarding parent-child interactions are lacking.

Contrary to previous research (e.g., Auerbach et al. 2001; Congdon et al., 2008; Schmidt et al., 2001) which found a direct association between the 7-repeat allele of the *DRD4* exon III VNTR and EC related constructs, the current study did not find a main effect for *DRD4* genotype. Considering that these studies all had smaller sample sizes than ours, these previous papers may have produced chance findings. It is also possible that this genetic variant does not influence the facet of EC captured by our tasks. EC is a broad construct comprised of several components including attentional and inhibitory control; while the current study examined the inhibitory control aspect of EC, these other studies typically focused on the attentional aspects of EC (Auerbach et al., 2001; Schmidt et al., 2001) or on inhibitory control as defined in the executive functioning literature (Congdon et al., 2008). Alternatively, this inconsistency could be the result of our choice of how to group allelic variants. In the present study, children with and without the 7-

repeat allele were separated into two groups; however, previous studies have also chosen to group alleles based on short and long variants (i.e., greater or less than 6 repeats; Schmidt et al., 2001), Unfortunately, given the rarity of some *DRD4* exon III VNTR alleles in our sample, testing associations between multiple genotypes was not possible in the present study. Our decision to focus on the 7-repeat variant is consistent with most published research, and permitted us to extend and replicate previous work from our group on this variant.

In our sample, children without a 7-repeat allele were more likely to have primary caregivers who utilized an authoritarian parenting style, suggesting the possibility of a gene-environment correlation (rGE; Rutter, 2006). While a handful of papers reporting rGEs have emerged in recent years (Jaffee & Price, 2007; Mills-Koonce et al., 2007; Propper et al., 2008), these have not focused on the *DRD4* polymorphism examined in the present study. Given the lack of relevant research, no specific hypotheses were made about the existence of an rGE between children's *DRD4* genotypes and parenting in the present study; however, the finding obtained is arguably in the opposite direction from what might be expected. Given the literature indicating an association between the 7-repeat allele and impulsivity, novelty seeking, aggressive behavior and attention difficulties, one might expect that children with a 7-repeat allele would evoke greater negative parenting than those without a 7-repeat allele. Such an rGE might emerge through evocative or passive mechanisms; for example, having a 7-repeat might lead to impulsive child behavior that necessitates greater parental control, or an rGE might emerge if parents themselves engage in poorer parenting practices due to having a 7-repeat themselves. It is more difficult to formulate plausible reasons for the opposite

pattern of associations found in the present study. However, perhaps parents are less understanding or tolerant of rule violations if they do not possess a 7-repeat themselves, and are consequently are more strict disciplinarians with respect to parenting style. It is also possible that this finding is due to chance. Future research should investigate mediation models and how child behaviors might account for this observed gene-environment correlation.

As previously discussed, correlations between laboratory observations and caregiver-reports of parenting have been modest, and our results are consistent with this finding (Zaslow et al., 2006). As expected, given the behaviors that contributed to the observed negative parenting aggregate, this scale was positively correlated with caregiver reports of authoritarian parenting. This indicates that parents who were observed to utilize more negative parenting strategies also reported using more cold and controlling techniques. A weaker association was also found between observed negative parenting and indulgent parenting. This indicates that parents who were observed to utilize more negative parenting strategies also reported themselves as more likely to give in to their children's demands. As expected, positive observed parenting was positively correlated with primary caregiver-reports of authoritative parenting, indicating that parents observed to use more positive techniques were also more likely to report themselves as being authoritative in parenting style. Also as expected, positive observed parenting was negatively associated with primary caregiver reports of authoritarian and indulgent parenting. This suggests that parents who were observed to use more positive techniques were less likely to report themselves as being indulgent or authoritarian in style.

Interestingly, primary and secondary caregivers' reports of parenting were

positively associated, indicating similarity of self-reported parenting across caregivers. This is consistent with previous research suggesting that partners typically display similar parenting styles (e.g., Baumrind 1973, Simons & Conger, 2007). Parenting strategies across caregivers could be similar for a variety of reasons. For example, personality has been shown to influence parenting style (Prinzie, Stams, Dekovic, Reijntjes, Belsky, 2009). Considering that individuals are drawn to mates with similar attributes and personalities (Russell & Wells, 1991; Simons & Conger, 2007), this trait similarity may predispose to similarities in caregiving. Alternatively, parenting strategies could be influenced by socialization such that each caregiver influences his/her partner's parenting strategies over time (Buss, 1984). Finally, a less commonly considered possibility is that child characteristics evoke particular parenting strategies, with similarities in parenting across caregivers resulting from child attributes. In addition, each caregiver's report of authoritarian parenting was positively correlated with the other caregiver's report of indulgent parenting, suggesting the possibility of caregivers attempting to offset a coparent's overly strict parenting style with a more indulgent approach to parenting.

Strengths, Limitations and Future Directions

This study built upon the existing literature examining whether *DRD4* exon III VNTR genotype and parenting interact in the development of early emerging EC. Our study extended previous work by: 1) the use of a relatively large sample size; 2) the incorporation of observational measures of EC; 3) differentiating between positive and negative parenting behaviours; 4) including caregiver-reported parenting for both primary and secondary caregivers; and by 5) assessing parenting in naturalistic home environments. However, our study also had some limitations. First, while EC has been

defined as a multifaceted construct (Rothbart et al., 2001), our EC tasks focused solely on the assessment of the inhibitory control aspects of the broader construct. Future research attempting to examine determinants of EC would benefit from the use of a more diverse array of tasks to create a more comprehensive profile of children's EC. Second, while the choice of a community sample was ideal for identifying potential interactions between positive parenting, *DRD4* and EC, it may have limited our ability to examine a wide range of negative parenting behaviors. Thus, future research interested in *DRD4* as a differential susceptibility factor should seek to maximize variance in measures of contextual variables by specifically recruiting high-risk samples (Ellis et al., 2011). Third, our attempt to examine interactions between primary and secondary caregivers was limited by the fact that we did not collect observational measures of the secondary caregiver's parenting. Fourth, it is important to note that we examined only a single genetic variant in the present study, though multiple genes likely interact to influence developing EC (e.g., Belsky & Beaver, 2011). Finally, given the cross-sectional nature of the current study, the direction and mechanism of causality associations between parenting and EC remain ambiguous. It is difficult to determine whether parenting behaviors influence children's EC or whether children's EC influences parenting. For example, it is plausible that children with poor EC elicit the use of more controlling parenting behaviors than children with better EC. A longitudinal study, conducted by Eisenberg and colleagues (2005), supported only the presence of unidirectional effects of parenting on children's EC, although it is possible that parenting and EC have bidirectional effects on each other over time. Future work should seek to examine these relationships longitudinally in order to better understand how parenting and children's EC shape one another over time, and

whether children's genetic polymorphisms influence these relationships.

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Appendix A: Coding of Effortful Control in Tower of Patience & Snack Delay

Subject ID:_____ Coder Initials:_____

Date:_____

Trials begin after the child places the block on the tower: T1-5ec; T2-10 sec; T3-15 sec; T4-no pause; T5-20 sec; T6-30 sec

1. Failure to wait turn: when a child does **NOT** wait for his/her turn in the epoch
Record # of times child does **NOT** wait turn in each epoch

-Criteria for NOT waiting turn:

a. Child preemptively places block on the tower

b. Child clearly tries to place block on tower, but is stopped by the experimenter

c. Child clearly tries to place the block on the tower but is too short.

2. # of prompts to experimenter: the number of prompts that the child directs to the experimenter during the epoch (this includes *physical motions/gestures* (i.e., child points finger) and *verbalizations* ("Go!" or "Put your block on!")). If child repeats any prompt in rapid sequence for longer than **4 seconds,** this may be best coded as an additional prompt (e.g., tapping the top of the tower repeatedly) this is different from two obviously distinct prompts that occur within the same 4 second period (e.g. "put it on", brief pause, "put it here"); if unsure, consult with another trained coder. When a verbal and physical prompt occur together (e.g. tapping tower and saying "put it on") it is coded as two separate prompts.

3. # of times child self-directs: the number of times child corrects his/herself from placing a block on the tower out of turn.

Tower #1: ( ) = delay time

Places first block: Experimenter or Child

Trial:	**1 (5s)**	**2 (10s)**	**3 (15s)**	**4 (none)**	**5 (20s)**	**6 (30s)**	**Total**
TALLY: Failure to wait							
TALLY: # of prompts							
TALLY: #child self-directs							

Tower #2: ( ) = delay time

Places first block: Experimenter or Child

Trial:	**1 (5s)**	**2 (10s)**	**3 (15s)**	**4 (none)**	**5 (20s)**	**6 (30s)**	**Total**
TALLY: Failure to wait							
TALLY: # of prompts							
TALLY: #child self-directs							

Subject ID:_____ Coder Initials:_____

Date:_____

Trials begin when snack is placed on plate: T1-no pause/practice trial; T2-5 sec; T3-10 sec; T4-no pause; T5-20 sec; T6-no pause; T7-30 sec

1. Failure to wait turn: Child does **NOT** wait for bell signal to **eat** snack in the epoch
Record # of times child does **NOT** wait turn in each epoch. Remember that the child must eat the snack in order for a failure to have occurred.

-Criteria for NOT waiting turn:

a. child preemptively picks up cup and eats snack **BEFORE** bell signal; **b.** child preemptively rings bell (that the experimenter is holding) and then picks up cup and eats snack; **c.** child grabs snack directly from bag and eats snack **or** child picks up snack from plate **BEFORE** cup is placed on top of snack and eats it

2. # of prompts to experimenter: code the number of prompts the child gives the experimenter during the epoch (this includes *verbal prompts* (i.e., "Go!", "I'm ready", "ring it"), and *physical prompts* (i.e., pointing to or shaking the bell)). If child repeats any prompt in rapid sequence for longer than **4 seconds,** (mock bell shaking motion) this may be best coded as an additional prompt (e.g., miming shaking motion repeatedly) this is different from two obviously distinct prompts that occur within the same 4 second period (e.g. "put it on", brief pause, "put it here"); if unsure, consult with another trained coder. When a verbal and physical prompt occur together (e.g. miming shaking motion and saying "put it on") it is coded as two separate prompts.

3. # of time child self-directs: the number of times child reaches to pick of the cup, but stops him/herself from picking up the cup BEFORE the bell signal

**If the child picks up the cup and holds the smarty in their hand until the experimenter rings the bell do not code it. They must either eat the smarty (failure to wait), prompt the experimenter to ring the bell, or reach for the cup and pull back (self-direct) to receive a code.

( ) = delay time

Trials:	**1 (none) practice**	**2 (5s)**	**3 (10s)**	**4 (none)**	**5 (20s)**	**6 (none)**	**7 (30s)**	**Total**
TALLY: Failure to wait								
TALLY: # of prompts								
TALLY: #child self-directs								

Appendix B: Parent-Child Interaction Tasks Coding Manual & Record Form

Note: This coding system is derived from the Teaching Tasks coding manual and Qualitative Ratings for Parent-Child Interactions (Weinfield, Egeland, & Ogawa, 1998; Cox & Crnic, 2003).

CODING

A. RATING SCALES

There are fifteen rating scales used for coding the parenting tasks. Seven of these scales focus on parent behavior, eight focus on child behavior, and two scales are more dyadic. The scales are:

Parent Sensitivity/Responsivity
Parent Detachment
Parent Supportive Presence
Parent Intrusiveness
Parent Hostility
Parent Quality of Instruction
Parent Confidence
Parent Positive Affectivity
Parent Negative Affectivity
Child Persistence
Child Interest/Engagement
Child Positive Affect
Child Negativity to Parent
Child Negative Affect
Child Compliance
Child Affection (positive orientation) to Parent
Child Avoidance of Parent
Quality of Relationship
Boundary Dissolution

Each scale is presented here, containing an initial description of the goals of the scale and a description of each rating point.

Parent Sensitivity/Resposivity: This scale focuses on how the parent observes and responds to their child's social gestures, expressions, and signals as well as how they respond to child negative affect. The key defining characteristic of a sensitive interaction is that it is child-centered. The sensitive parent is tuned to and manifests awareness of the child's needs, moods, interests, and capabilities, and allows this awareness to guide his/her interaction. A sensitive parent provides stimulation that is appropriate to the situation. He/she provides the child with contingent vocal stimulation and acknowledges the child's interest, efforts, affect, and accomplishments. A sensitive parent can spend time just watching the child but the difference between them and a detached parent is that the sensitive parent seems to be actively taking an interest in the child's activities, as evidenced by comments and embellishments when the child loses interest. A sensitive interaction is well timed and paced to the child's responses, a function of its child-centered nature. Such an interaction appears to be "in sync". The parent paces toys and games to keep the child interested and engaged, but also allows the child to disengage and independently explore the toys. Some markers of sensitivity include: (a) acknowledging the child's affect; (b) contingent vocalizations by the parent; (c) appropriate attention focusing; (d) evidence of good timing paced to the child's interest and arousal level; (e) picking up on the child's interest in toys or games; (f) shared positive affect; (g) encouragement of child's efforts; (h) providing an appropriate level of stimulation when needed; and (i) sitting on floor or low seat, at child's level to interact.

1. **No Sensitivity.** There are almost no signs of parent sensitivity. Thus, the parent is either predominantly intrusive or detached. The parent rarely responds appropriately to the child's cues, and does not manifest awareness of the child's needs. Interactions are characteristically ill-timed or inappropriate. A parent who typically appears oblivious or punitive to the child's needs and affect would receive this score.
2. **Very Low**. This score would be given to parents who display weak or infrequent signs of sensitivity/responsiveness. While the parent is sometimes sensitive, the balance is clearly in the direction of insensitivity. The parent may give some delayed or perfunctory responses to cues from the child but the parent clearly appears more unresponsive than responsive.
3. **Low.** This rating should be given to parents who display some clear instances of sensitive responding. The parent can be characterized as sensitive to the child; however, the parent's behaviors may be mechanical in quality and ill-paced. The interaction can be characterized by a mixture of well-timed and faster paced episodes, or by a parent who is trying to be sensitive, but the interaction has signs of insensitivity. This rating may also be given to parents who are trying to interact appropriately with their child but he/she may appear not to know what to do. The parent is inconsistently sensitive and hard to categorize.
3. **Moderate.** This rating should be given to parents who are predominantly sensitive/responsive. The parent demonstrated sensitivity in most interactions but may neglect to give a fuller response or a well-timed, appropriate response. Some of the parent's responses are mixed, i.e. some are half-hearted or perfunctory, but the majority are full responses.

4. **High**. The rating should be given to parents who are exceptionally sensitive and responsive. Instances of sensitivity are rare and never striking. Interactions are characteristically well-timed and appropriate. Overall, most responses are prompt, appropriate, and effective.

Detachment/Disengagement: The detached parent appears emotionally uninvolved or disengaged and unaware of the child's needs. This parent does not react contingently to the child's vocalizations or actions, and does not provide the "scaffolding" needed for the child to explore objects in novel ways. Detached parents either miss or ignore the child's cues for help with toys and games, and their timing is out of synchrony with the child's affect and responses (although not the overwhelming barrage of stimulation that intrusive parents present). Simply allowing the child to play by him/herself is not necessarily a sure sign of detachment; this can be appropriate at times, such as when the child is playing happily or contentedly and the parent checks in with the child visually. The detached parent will remain disengaged even when the child makes a bid for interaction with the parent. The detached parent is passive and lacks the emotional involvement and alertness that characterizes a sensitive parent. He/she appears uninterested in the child. There may be a "babysitter-like" quality to the interaction in that the parent appears to be somewhat attentive to the child, but behaves in an impersonal or perfunctory manner that fails to convey an emotional connection between the parent and the child. Other parents may demonstrate a performance-orientation in that the interaction is tailored towards performing for the camera rather than reacting to and facilitating child-centered behavior.

1. **Not Detached**. This rating should be given to parents who display almost no signs of detachment or under involvement. When interacting with the child, the parent is clearly emotionally involved. These parents can be sensitive or intrusive.

2. **Minimal Detachment**. This rating should be given to parents who display minimal signs of detachment. While they are clearly emotionally involved with the child during most of the interaction, there may be brief periods of detachment.

3. **Somewhat Detached**. This rating should be given to parents who remain involved and interested in the child while at the same time demonstrating the tendency to act in an uninterested, detached or perfunctory manner. Parents alternate between periods of engagement and disengagement. The periods of disengagement may be marked by unemotional or impersonal behavior. There may be a low-level of impersonal/unemotional behavior running throughout the interaction.

4. **Moderately Detached**. This rating should be given to parents who are predominantly detached. While there may be periods of engagement, the interaction is characterized chiefly by disengagement. The parent may be passive and fail to initiate interactions with the child. When interactions do occur, they

may be marked by an impersonal, perfunctory style. Parent may show a lack of emotional engagement throughout the interaction

5. **Highly Detached**. This rating should be given to parents who are extremely detached. The child plays without parent attention almost all of the time, even when the parent is within a suitable distance for interacting. In the minimal instances of involvement, the parent's behaviors are simple, mechanical, stereotyped, bland, repetitive, and perfunctory. The parent is clearly not emotionally involved with the child, and appears to be "just going through the motions".

Parent Supportive Presence: A parent scoring high on this scale expresses positive regard and emotional support to the child. This may occur by acknowledging the child's accomplishments on task the child is doing (e.g. building a house of blocks), encouraging the child with positive emotional regard (e.g. "You're really good at this"/"You got another one right") and various other ways of letting the child know that he/she has their support and confidence to do well in the setting (e.g. positive reassuring voice tone). If the child is having difficulty with a task, the parent is reassuring and calm, providing an affectively positive "secure base" for the child, perhaps leaning closer to the child to give a physical sense of support. A parent scoring low on this scale fails to provide supportive cues. They might be passive, uninvolved, aloof, or otherwise unavailable to the child. Such a parent also might give observers the impression that they are more concerned about their own adequacy in the setting than their child's emotional needs. A potential difficulty in scoring this scale is to discount messages by the parents that seemingly are supportive in verbal content but are contradicted by other aspects of the communication (e.g., the parent seems to be performing a supportive role for the camera and not really engaged in what the child is doing or feeling). Signs of such questionable support are improper timing of support, mismatch of verbal and bodily cues, and failure to have the child's attention in delivering the message. These types of supportive messages would not be weighted highly because such features suggest that supportive presence is not a well practiced aspect of their interaction outside the laboratory setting.

1. Parent completely fails to be supportive to the child, either being aloof and unavailable or being hostile toward the child when the child shows need of some support.

2. Parent provides very little emotional support to the child. Whatever supportive presence is displayed is minimal and not timed well, either being given when the child does not really need it, or only after the child has become upset.

3. Parent gives some support but it is sporadic and poorly timed to the child's needs. The consistency of this support is uneven so as to make the mother unreliable as a supportive presence.

4. Parent does a respectable job of being available when their child needs support. The

parent may lean closer as the child shows small signs of frustration and praise the child's efforts to show that they are available and supportive, but inconsistency in this style makes support unreliable or unavailable at crucial times in the session.

5. Parent provides good support, reassurance and confidence in the child's ability, but falters in this at times when the child especially could use more support. Or, parent is universally supportive but gives no evidence of modulation to the child's needs.

6. Parent establishes him/herself as supportive and encouraging toward the child and continues to provide support when the child needs it. As the child experiences more difficulty, parent support increases in commensurate fashion. The parent has some lapses, however, in which the child's performance wavers for lack of support. Yet, they redouble support and attempt to return the child to a level of confidence that is more optimal.

7. Parent skillfully provides support throughout the session. Parent sets up the situation from the beginning as one in which they are confident of the child's efforts. Parent may reject inadequate solutions to problems in a way that does not reduce their support and confidence in the child's ability to get the correct solution. If the child is having difficulty, the parent finds ways to encourage whatever solution the child can make. Parent not only is emotionally supportive but continuously reinforces the child's success.

Parent Intrusiveness: A parent scoring high on this scale lacks respect for the child as an individual and fails to understand and recognize the child's effort to gain autonomy and self awareness. This parent interferes with the child's needs, desires and interests or actual behaviors. The parent's behavior is guided more by their own agenda rather than the child's needs. Reasonable or appropriate limit setting or directing the child's behavior to the task may be intrusive, depending on the content of the parent's involvement. Setting limits is crucial to the socialization process at this age, and giving the child directives is part of many tasks. **But behaviors are intrusive if they indicate a lack of respect for the child.** Intrusiveness can occur in a harsh physical manner (parent grabbing the child's arms or hands and placing them somewhere else), or with affection (**inappropriate** contact which interferes with the child's efforts, such as kissing, hugging, etc.), or if the parent does not allow the child autonomy in problem-solving tasks (imposes directions and does not allow opportunities for self-directed efforts). It is important that intrusiveness be evaluated from the perspective of the child. Look at cues from the child preceding or after the parent's behavior to see how the child has perceived the parent's action; and what may seem as intrusive to the coders, may not be to the child (e.g., if fast-paced stimulation from the parent is enjoyed by the child, as shown by smiles or laughter, parental behavior that would otherwise be judged as intrusive will not be counted as such. However, because this judgment is highly subjective, this aspect should not carry a lot of weight when coding, but attention to context is important.)

1. **No Intrusiveness:** No sign of intrusiveness. The parent may be involved yet continues to

respect the child's needs, or may alternatively be totally uninvolved with the child and appear withdrawn. In either case, the parent does not impose directives on the child unless it is clear that the child needs direction. If directives are given, it is in a manner showing respect for the child.

2. **Very Low**: Parent may show subtle signs of being intrusive, i.e. stepping in to help before the child demonstrates need, but the child does not perceive these as intrusive and is not upset by them.

3. **Moderately Low:** There is some indication of intrusiveness but it is not pervasive. These instances are of low intensity and again may not cause the child to become upset. For example, the parent may redirect the child to a new toy/task in a poorly timed fashion. Alternatively, low level intrusiveness may be "chronic"; however, the child has the opportunity to do some exploration.

4. **Moderate**: Clear signs of intrusiveness and/or a feeling of intrusiveness that is easily or clearly picked up by the coders, but parent still allows the child periods of exploration or autonomy. The instances of intrusiveness are generally of low intensity (i.e. the parent provides new instruction before the child has had a chance to complete the last task), yet there may be one high level act at an inappropriate time or there may be an episode of rough physical handling.

5. **Moderately High**: Clear signs that parent does not respect the child's needs and interests. There may be a couple high intensity, or several low level intrusive interactions. E.g., parent may often grab objects from the child, issue directives with no regard for child's response, or do much of the task for the child. However, parent may allow the child **some periods of exploration or autonomy**.

6. **High:** Clear incidents of intrusiveness throughout the session, and the parent's agenda clearly has precedence over the child's needs and interests. There may be either several high intensity intrusive interactions or persistent low level intrusive interactions. E.g., the parent may grab the child and physically direct behavior more than once, or the parent may be uninvolved for long periods, **but whenever they do interact, these interactions are consistently intrusive. Parent also allows for less autonomy than exhibited in #5.**

7. **Very High:** A highly intrusive parent's agenda clearly has precedence over the child's. Parent frequently intervenes inappropriately without cues from the child, and reacts to his/her own schedule rather than the child's needs. Frequent high level indicators (i.e. takes stimulus out of child's hands, no regard for what child wants to do, > #6) are pervasive throughout the session (i.e. parent appears to be doing task him/herself). Shows assertiveness to get the child to comply with their wishes which are not task related.

Parent Hostility: This scale reflects the parent's expression of anger, frustration, annoyance, discounting or rejecting of the child. A parent scoring high on this scale

would clearly and openly reject the child, blame him or her for mistakes, and otherwise make explicit the message that they do not support the child emotionally. A parent scoring low on this scale may be either supportive or cold and show some expressions of anger, frustration, or annoyance, but they do not blame or reject the child. A rejecting parent may also show some Supportive Presence (and the inconsistency of their behavior would be revealed by these two scores). Given the low frequency and the clinical relevance of rejecting one's child during a videotaped session, any events which are clearly hostile should be weighted strongly in this score.

1.**Very low**: Parent shows no signs of anger, annoyance, frustration, or rejection. They may or may not be supportive, but they do not try to put down the child or avoid the child in rejecting ways. Passive or emotionally uninvolved parents would be included here if the parent did not reject the child or communicate hostility toward the child.

2. **Low:** Parent did one or two things that seemed to communicate a little hostility (i.e. anger, frustration, annoyance) toward the child. These messages were not overt but rather muted expressions toward the child (e.g., pulling away something with a jerk, putting hand on their hip to show exasperation, giving a negative look at the child briefly, having an exasperated tone of voice, parroting or mimicking the child in a negative fashion).

3. **Moderately low:** Signs of hostility again are very fleeting, but they occurred on several occasions during the session, and at least one sign could be identified as clear and overt or an accumulating sense of unexpressed anger and avoidance toward the child was seen in the parent's behavior.

4. **Moderate**: Several instances of hostile or rejecting behaviors. Two or more of these events are reliably clear to observers, but expressions are brief and do not set the tone of parent's interactions immediately following the episodes.

5. **Moderately high**: Parent is overtly rejecting or hostile several times. Behaviors include overt and clearly communicated rejections of child and expressions of hostility or anger which appear intermittently through substantial periods of the session. This parent's behavior is more rejecting than not, either by the frequency of hostile behavior or by the potency by which rejection is communicated several times in the session.

6. **High**: Parent has frequent expressions of rejection and hostility directed toward the child. There is little or no effort to show warmth during substantial portions of the session, especially after parent becomes irritated with the child (i.e., parent may initially be warm and then rejects the child strongly). Parent is frankly and directly rejecting and hostile (e.g., telling child they will leave him/her behind if he/she does not do the task/play with the toy, using negative performance feedback but little positive feedback, blaming the child for incompetence on the tasks, and overtly refusing to recognize the child's success, e.g., "You couldn't have done it without me showing you!"). Any warmth seems superficial relative to the parent's distancing from the child, and rejection is used as a control technique against the child.

7.**Very high**: Parent shows characteristics of the previous scale point, but expressions of anger toward the child also are accompanied by strong, barely controlled emotions, suggesting the possibility of physical abuse and neglect of the child in some situations.

Parent Quality of Instruction: The important features of this rating are how well the parent structures the situation so that the child knows what the task objectives are and receives hints or corrections while solving the problems that are: (a) timely to his/her current focus, (b) paced at a rate that allows comprehension and use of each hint, (c) graded in logical steps that the child can understand, and (d) stated clearly without unnecessary digressions to unrelated phenomena or aspects of the task that might only confuse the child. The parent's approach suggests that they have some sort of plan for how their instructions will help the child. Yet, the parent is also flexible in their approach and uses alternative strategies or rephrases suggestions when a particular cue is not working, and they coordinate their suggestions to the effort that the child is making to solve the task. **See attached list for a more complete description of the components of quality instruction.**

1. Parent's instructions are uniformly of poor quality. They either are totally uninvolved or fail to structure the tasks so that the child understands what is required, and the parent gives clues that are of no help to the child's problem-solving efforts and appear to embody no effective plan of teaching.

2. Parent occasionally gives effective instruction. Parent may be able to structure the tasks so that the child understands what to do and gives a few helpful hints to the child, but these are minimal compared to the ineffectiveness of most of their attempts or lack of attempts.

3. Parent effectively structures some portions of the tasks and provides good hints, but their assistance is inadequate for much of the session.

4. Parent provides adequate structure and instruction for the child to work on the tasks during much of the session, but overall their instruction is lacking in major ways at several points during the session. Alternatively, the parent may approach tasks in a way that is very structured but requires the child to attend primarily to their directives and allows little opportunity for the child to engage the tasks directly (i.e., the parent therefore does not have to coordinate their teaching to the child's efforts); **the result is that the child does not gain a sense of competence in performing the tasks.**

5. Parent generally provides instruction that is sufficient and appropriate, but there are some periods in which it is inadequate in amount or quality. Alternatively, the parent may approach tasks in a way that is very structured but requires the child to attend primarily to their directives and allows little opportunity for the child to engage the task directly (i.e., the parent therefore does not have to coordinate their teaching to the child's efforts); **yet, despite their directiveness, child still gains a sense of**

competence.

6. Parent's instruction demonstrates **most** of the desirable features for this rating and in general the parent appears to provide good help throughout the session.

7. Parent demonstrates **almost all** the characteristics of effective instruction consistently throughout the session. The tasks are sufficiently structured so that the child understands the objectives and can attempt to solve the problems directly. Parent's assistance coordinated to the child's activity and needs for assistance.

Components of Quality of Instruction (indicative of high quality instruction)
-obtains child's attention

-explains the goal of the task in a developmentally appropriate manner

-provides instructions which are contingent upon the child's previous action (e.g., child picks up a block; parent
then tells child to find one that looks the same)

-structures the task into logical steps

-has a range of strategies which they can apply in response to the child's actions

-changes strategies when the current one is not working and does so in a timely manner

-provides appropriate feedback (e.g., okay, that's it, try again)

-uses developmentally appropriate language that their child can understand

-times their instructions based on child's actions; does not present instructions too quickly (while child is still
working on previous step) or too slowly (long after the child first shows indications of needing help)

-persists despite difficulties; does not give up

Parent Confidence: Degree to which the parent seems to believe that they can work successfully with the child in the situation and that the child will behave appropriately (whether this is more or less task oriented depends on parent's definition of the situation as a social or achievement oriented activity).

1. **Mostly unconfident**: Parent is uncertain in interactions with their child, being either unduly tentative, restricting, or appeasing (or a combination of these behaviors). Signs of a lack of confidence include doing the tasks for the child, appeasing the child by letting him do what he wants, overkill with strong reinforcement, showing clear signs

of relief when the tasks go successfully, periodic checking with the experimenter to see if they are "doing it right", apologizing for behavior, and/or anxious laughter and giggling in response to their own or their child's efforts. There may be a sense that they are trying to deal with problem situations by using such tactics that distract from the issue rather than dealing with it directly. Alternatively, a parent may not show tentativeness, but be overly power assertive/ intrusive /grabby in their attempts to control her child's behavior.

2. **Somewhat unconfident**: Parent seems fairly confident that they can interact with the child in ways that will be satisfactory; however they do show some evidence of hesitancy or appeasement or anxiety in making requests of the child. A few signs of a lack of confidence (as described above in 1) may be present but are not pervasive and do not persist throughout the session.

3. **Mostly confident**: Parent is quite confident that their interactions with the child will proceed in an acceptable manner and that they need not take special precautions to ensure this. Parent seems relaxed about interacting with their child and seems to believe that they could deal adequately with any problems that might arise. Parent trusts in their instincts and skills as a parent (whether or not we as coders believe that they should!).

Parent Positive Affectivity: This scale is a measure of the frequency and intensity of the parent's expression of positive affect (PA). Positive affect includes facial, vocal, and bodily components. A high score on this scale may be obtained even if the parent expresses negative affect in the session.

1. **Low Parent PA**: Parent shows very little or no positive affect throughout entire session. Examples of low parent PA include lack of smiling, low energy, and subdued/ blunted/ flat affect.

2. **Moderate Parent PA**: Parent exhibits a few instances of positive affect (i.e. slight smiles). The majority of the PA displayed is of low intensity; however, there may be clear, but few, instances of moderate/high intensity PA (i.e. laughing, hugging the child). These elements are only minor elements of the session and are not expressed frequently or consistently.

3. **High Parent PA**: Parent clearly expresses PA at a level that is more intense and frequent than in #2. Parent appears energetic and engaged. Parent may display frequent low level instances of PA (i.e. contentment, smiling), but also displays several high level instances of PA.

Parent Negative Affectivity: This scale is a measure of the frequency and intensity of the parent's expression of negative affect (NA). Negative affect includes facial, vocal, and bodily components. A high score on this scale may be obtained even if the parent expresses positive affect in the session.

1. **Low Parent NA**: Parent shows very little or no negative affect throughout entire session. Examples of low parent NA include lack of irritability, frustration, or any other form of NA (i.e. anger, sadness, fear).

2. **Moderate Parent NA**: Parent exhibits a few instances of negative affect. The majority of the NA displayed is of low intensity (i.e. slightly negative tone of voice). These elements are only minor elements of the session and are not expressed frequently or consistently.

3. **High Parent NA**: Parent either expresses (1) consistent low levels of NA throughout session, or (2) at least two clear instances of NA that are of greater intensity than in #2 (i.e. shouts at child, grabs child)

Start time: **Stop time:**

Coder Initials: **Date:**

Behavior	Notes/Comments	Score
Parent Sensitivity/Responsiveness		
Parent Detachment		
Parent Supportive Presence		
Parent Intrusiveness		
Parent Hostility		
Parent Quality of Instruction **(code for puzzles with parent task only)**		
Parent Confidence		
Parent Positive Affectivity		
Parent Negative Affectivity		

Appendix C: Parenting Styles and Dimension Questionnaire

Please rate how often you exhibit each behavior with your child.

I EXHIBIT THIS BEHAVIOR:
1 = Never
2 = Once In Awhile
3 = About Half of the Time
4 = Very Often
5 = Always

_____ 1. I am responsive to our child's feelings and needs.
_____ 2. I use physical punishment as a way of disciplining our child.
_____ 3. I take our child's desires into account before asking the child to do something.
_____ 4. When our child asks why he/she has to conform, I state: because I said so, or I am your parent and I want you to.
_____ 5. I explain to our child how we feel about the child's good and bad behavior.
_____ 6. I spank when our child is disobedient.
_____ 7. I encourage our child to talk about his/her troubles.
_____ 8. I find it difficult to discipline our child.
_____ 9. I encourage our child to freely express himself/herself even when disagreeing with parents.
_____ 10. I punish by taking privileges away from our child with little if any explanations.
_____ 11. I emphasize the reasons for rules.
_____ 12. I give comfort and understanding when our child is upset.
_____ 13. I yell or shout when our child misbehaves.
_____ 14. I give praise when our child is good.
_____ 15. I give into our child when the child causes a commotion about something.
_____ 16. I explode in anger towards our child.
_____ 17. I threaten our child with punishment more often than actually giving it.
_____ 18. I take into account our child's preferences in making plans for the family.
_____ 19. I grab our child when being disobedient.
_____ 20. I state punishments to our child and do not actually do them.
_____ 21. I show respect for our child's opinions by encouraging our child to express them.
_____ 22. I allow our child to give input into family rules.
_____ 23. I scold and criticize to make our child improve.
_____ 24. I spoil our child.
_____ 25. I give our child reasons why rules should be obeyed.
_____ 26. I use threats as punishment with little or no justification.
_____ 27. I have warm and intimate times together with our child.
_____ 28. I punish by putting our child off somewhere alone with little if any explanations.

____ 29. I help our child to understand the impact of behavior by encouraging our child to talk about the consequences of his/her own actions.

____ 30. I scold or criticize when our child's behavior doesn't meet our expectations.

____ 31. I explain the consequences of the child's behavior.

____ 32. I slap our child when the child misbehaves.

Office of Research Ethics

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Use of Human Subjects - Ethics Approval Notice

Principal Investigator: Dr. E.P. Hayden
Review Number: 15121S **Review Level:** Full Board
Review Date: May 2, 2008

Protocol Title: Gene-Environment Interplay and the Development of Child Temperament
Department and Institution: Psychology, University of Western Ontario
Sponsor: CANADIAN INSTITUTE OF HEALTH RESEARCH
Ethics Approval Date: June 11, 2008 **Expiry Date:** July 31, 2013
Documents Reviewed and Approved: UWO Protocol, Letter of Information and Consent (Parent Consent for Self), Letter of Information and Consent (Parent Consent for Child), Advertisement.
Documents Received for Information:

This is to notify you that The University of Western Ontario Research Ethics Board for Non-Medical Research Involving Human Subjects (NMREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the applicable laws and regulations of Ontario has granted approval to the above named research study on the approval date noted above.

This approval shall remain valid until the expiry date noted above assuming timely and acceptable responses to the NMREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the UWO Updated Approval Request Form.

During the course of the research, no deviations from, or changes to, the study or consent form may be initiated without prior written approval from the NMREB except when necessary to eliminate immediate hazards to the subject or when the change(s) involve only logistical or administrative aspects of the study (e.g. change of monitor, telephone number). Expedited review of minor change(s) in ongoing studies will be considered. Subjects must receive a copy of the signed information/consent documentation.

Investigators must promptly also report to the NMREB:

a) changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
b) all adverse and unexpected experiences or events that are both serious and unexpected;
c) new information that may adversely affect the safety of the subjects or the conduct of the study.

If these changes/adverse events require a change to the information/consent documentation, and/or recruitment advertisement, the newly revised information/consent documentation, and/or advertisement, must be submitted to this office for approval.

Members of the NMREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the NMREB.

Chair of NMREB: Dr. Jerry Paquette

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