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THE ASSOCIATIONS BETWEEN FAMILY VIOLENCE, DRD4 POLYMORPHISMS, AND CHILDREN'S REGUALTORY OUTCOMES

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ABSTRACT

This study examined whether the 7- repeat dopamine D4 receptor (DRD4) genetic polymorphism moderated the relationship between family violence (FV) exposure and children's effortful control (EC). Eighty-four mother and child dyads were recruited through Child Protective Services (CPS), Department of Public Welfare, and birth announcements. FV was determined from a maternal assessment of interpartner violence (IPV) and from coding of Child Protective Service (CPS) records for severity of child maltreatment (CM). IPV and CM scores were standardized to create a composite FV score for each dyad. Children's EC scores came from two Stroop-like procedures. Researchers also collected cheek cells from children, which were assayed for genetic information. A multiple regression analysis was conducted and revealed that children exposed to greater FV performed more poorly on EC tasks. Further, DRD4 did not moderate the relationship between FV exposure and children's EC. These findings suggest that FV exposure negatively affects the development of EC regardless of whether the children have the DRD4 genetic polymorphism.

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Chapter 1

Introduction

In the United States and around the world family violence (FV) is a serious problem. Although it is difficult to know exactly how many children this issue affects, the Pennsylvania Coalition Against Domestic Violence (PCADV; 2012) estimates that approximately 3-10 million children in the U.S. witness domestic violence each year and that 30-60% of them are also victims of this abuse. Research has demonstrated that children exposed to this kind of violence are at risk for a variety of negative outcomes. For example, children exposed to abuse, or even to insensitive or harsh parenting, are at risk for developing a variety of psychological problems. In a literature review, Mulvihill (2005) summarizes that children exposed to trauma are at risk for depression, substance abuse, multiple personality disorder, eating disorders, and Posttraumatic Stress Disorder (PTSD). They are also at risk for physical illnesses, including rheumatoid arthritis, autoimmune disorders, and chronic diseases. In a comprehensive study of child maltreatment (CM) and other markers of allostatic load, Rogosch, Dackis, and Cicchetti (2011) found that CM independently predicts a variety of child health problems including an increased need for medication, more impairments, higher rates of diagnoses of medical or psychiatric illnesses, and more frequent utilization of health care.

Rogosch and colleagues (2011) have also found that CM exposure is associated with greater internalizing symptoms, externalizing symptoms, and total behavior problems in children. Specifically, CM exposure correlates with higher rates of social problems, delinquent behavior, and aggressive behavior (e.g. Cicchetti & Toth, 2005; Rogosch et al., 2011). Alink, Cicchetti, Kim, and Rogosch (2012) also found that children exposed to CM exhibited more disruptive, aggressive, and withdrawn behavior that their non-CM exposed peers. Maltreated children exhibited fewer prosocial behaviors, such as being considerate or cooperative (Alink et al., 2012). Cicchetti and Toth (2005) also summarized that research consistently demonstrates that children who have experienced CM are more likely to develop antisocial patterns of behavior than their non-CM exposed peers. Not only are maltreated children more likely to have trouble making and keeping friends, they are also more likely to become bullies or the victims of bullying than their peers (Cicchetti & Toth, 2005).

Other findings from research on children who have experienced CM have demonstrated a variety of other negative outcomes related to neurobiological functioning, attachment relationships, and school functioning. For example, greater allostatic load predicted more attention problems in maltreated children (Rogosch et al., 2011). Children exposed to CM may also have impaired cortisol regulation, which could put them at greater risk for future psychiatric problems (Alink et al., 2012). Children exposed to CM are also 61-86% less likely than their non-maltreated peers to be securely attached to their caregivers, and this pattern has been shown to persist into the pre-school and school-age years (Cicchetti & Toth, 2005). Finally, children exposed to CM are at risk for academic difficulties (Cicchetti & Toth, 2005).

Although being the direct victim of violence puts children at risk, children are also adversely affected when they witness interpartner violence (IPV). Specifically, Fantuzzo and Mohr (1999) found that children exposed to greater IPV are more likely to have externalizing problems; internalizing problems such as depression, anxiety, phobias, and low self-esteem; intellectual and academic problems such as difficulty concentrating and poor performance; social problems such as poor problem-solving skills, increased aggression towards peers, and less empathy; and physical problems (Fantuzzo & Mohr, 1999). Davies and Cummings (1994) found that children in homes with IPV are also significantly more likely (up to four times more likely) than their peers to develop psychopathology. For example, like their maltreated peers, children exposed to violence for a significant portion of their lives are at increased risk for PTSD (Holden, 2003). Children's physical health can also be negatively affected by both the physical nature of some of the violence as well as the immune system changes that can result from living under chronic stress (Fantuzzo & Mohr, 1999; Mulvihill, 2005). In general, children show distress when exposed to violence between adults, and this exposure can impact their behavior, emotions, cognition, and physiology (Davies & Cummings, 1994).

Children living with domestic violence are very likely to be exposed to '"the repeated pattern of behavior that conveys to children that they are worthless, unloved, unwanted, only of value in meeting another's needs, or seriously threatened with physical or psychological violence"' (Holden, 2003, p. 156), and for this reason, Holden (2003) argues that researchers and health professionals should include children exposed to domestic violence in the category of maltreated children. However, inter-adult conflict does not have to be physically violent to have a negative impact on children exposed to it. For example, Cummings, Iannotti, and Zahn-Waxler (1985) found that when exposed to verbal conflict versus positive adult interaction, children showed increased distress and rated it as the third most distressing factor in their lives (Davies & Cummings, 1994). If exposed to adult conflict a second time, children showed even more distress and increased aggression, suggesting that repeated exposure to adult conflict can cause increases in negative emotional and behavioral reactions (Cummings et al., 1985).

As explained above, children exposed to violence both directly and indirectly show poorer outcomes than children in non-violent homes. IPV and CM can also co-occur, and exposure to one often increases the risk of exposure to the other (Fantuzzo & Mohr, 2005). It is estimated that 45-70% of children exposed to domestic violence are also victims of direct abuse, and 40% of child abuse victims are also exposed to IPV (Fantuzzo & Mohr, 2005). Some studies have shown that children exposed to both have worse outcomes than children exposed to only one or to neither, suggesting it is important to include both risk factors in the exploration of the effects of violence exposure on children's outcomes (Fantuzzo & Mohr, 2005). However, most studies look at these environmental factors separately. Although researchers have investigated how factors such as socioeconomic status (Gaensbauer, 1982) and other markers of allostatic load combine with FV (Rogosch et al., 2011), few have looked at how different aspects of FV combine to affect children's subsequent outcomes.

Another outcome that is affected by FV is children's abilities to self-regulate their behavior (Cicchetti & Toth, 2005). Self-regulation, which is the set of processes that modulate reactivity (Rothbart, Sheese, & Posner, 2007), includes a variety of behavioral, emotional, and attentional processes, such as complying with requests, and initiating, ceasing, and postponing behaviors according to changing situational demands (Eisenberg et al., 2004; Kopp, 1982). Especially important to self-regulation are executive attention and effortful control (EC; Rothbart, Sheese, Rueda, & Posner, 2011).The Rothbart model defines EC as "the ability to voluntarily regulate behavior and attention, as seen in the inhibition of a dominant response and activation of a subdominant response" (Rothbart et al., 2011, p. 207).

This complex construct begins to develop when children are 2-3 months old. At this time, behavior and affect are regulated by neurophysiological mechanisms and reflexes (Kopp, 1982). In the next developmental stage, sensorimotor modulation, children begin to modulate behaviors in response to their consequences, but they do this without an understanding of the meaning of the behavior (Kopp, 1982). Control develops at the end of the first year as children begin to comply with adult requests and use social cues to modulate their behavior (Kochanska, Coy, &

Murray, 2001; Kopp, 1982). EC is one of the earlier-developing aspects of self-regulation, emerging around one year of age, and as such, its development influences that of many other more complex processes (e.g. emotion-regulation, social skills, etc.; Kochanska, Murray, & Harlan, 2000). Self-control emerges around two years of age (Kopp, 1982) and children learn to delay acts when requested and follow social expectations for behavior without external sources of control (Kochanska et al., 2001). Finally self-regulation occurs when children develop flexibility in their self-control so that they can apply it appropriately despite constant changes in the demands placed on them (Kochanska et al., 2001).

As stated above, it is important to study self-regulation rather than just broad behavior and affective indices because self-regulation predicts a number of subsequent behavior problems and mental health issues (e.g. Eisenberg et al., 2004; Murray & Kochanska, 2002). Self-regulation is linked to prosocial behavior, social skills, and effective coping and stress-relieving skills (Kochanska et al., 2000). Many researchers have suggested that behavioral inhibition, or the ability to suppress inappropriate behavior (Kochanska et al., 2001), underlies problems like ADHD, conduct disorder, learning deficits, and adolescent drug use (Murray & Kochanska, 2002). Eisenberg and colleagues (2004) hypothesized that attention regulation allows children to regulate their emotions, to process information from their environment, and to plan their actions. Even at twelve years old, self-control has been found to predict physical and mental health, personal wealth, and criminal and antisocial behavior, beyond the effects of intelligence and socioeconomic status (SES; Moffitt et al., 2010).

EC specifically seems to be important in certain developmental processes. For example, in a year-long longitudinal study, Kochanska and colleagues (2000) demonstrated that better EC at 22 months old predicted more regulated emotions (both positive and negative emotions) as well as better self-restraint at 33 months old. Eisenberg and colleagues (2004) have demonstrated that externalizing problems are negatively correlated with EC and positively correlated with impulsivity, which is in turn predicted by low EC. Eisenberg and colleagues (2009) have also found that low attentional and inhibitory EC predicts consistently high or increasing levels of externalizing problems in elementary school, while high EC predicts consistently low or decreasing levels of externalizing problems. Similarly Obradovic (2010) has demonstrated that even after controlling for child IQ, parenting quality, and socio-demographic risk factors, higher EC is associated with fewer externalizing behaviors and higher academic and peer competence. Overall, high EC predicts resiliency, defined as high academic and peer competence and non-clinical levels of internalizing and externalizing problems, such that, for each standard deviation increase in EC, children are 5.4 times more likely to be resilient (Obradovic, 2010).

Other studies have suggested that EC is associated with behavior problems in a way that suggests that both over-regulation and under-regulation can be problematic (Murray & Kochanska, 2002). Murray and Kochanska (2002) found that EC was associated with maternal reports of behavior problems in a U-shaped pattern so low and high levels of EC predicted more problems and that high EC predicted internalizing problems while low EC predicted attention problems. However, increases in and consistently high levels of internalizing problems have also been associated with low levels of attentional EC (Eisenberg et al., 2009). Also, Eisenberg and colleagues (2004) found that in place of a direct relationship, greater internalizing problems were negatively correlated with resiliency, which in turn was positively predicted by EC.

FV has been shown to have a significant impact on different aspects of self-regulation related to EC. For example, Pollak, Vardi, Putzer Bechner, and Curtin (2005) have demonstrated that when exposed to a background of angry adult conflict, abused children exhibit a state of anticipatory monitoring of the conflict while their non-abused peers more quickly return to baseline. Abused children also tend to stay alert, particularly during post-conflict periods of unresolved anger, suggesting the resolution of the conflict is of importance to them (Pollak et al., 2005). IPV also affects children's EC; IPV during the first two years of life predicts lower EC at five years old (Gustafsson, Cox, & Blair, 2012). Even the sensitivity of parenting has been correlated with EC (Eisenberg et al., 2005). Specifically, warm parenting has predicted higher EC in children four years later (Eisenberg et al., 2005).

Deficits in EC caused by exposure to FV may be what lead to future behavioral, social, and psychological problems (Eisenberg et al., 2005; Robinson et al., 2009). Robinson and colleagues (2009) found that CM exposure predicted lower positive affect intensity, higher anger intensity, and more internalizing problems in children and that for children exposed to CM, lower positive affect and higher anger were associated with internalizing problems, while low EC was marginally correlated with externalizing problems. Emotion regulation was not associated with psychopathology for the non-CM group, suggesting that regulation is more closely associated with psychopathology in children exposed to CM (Robinson et al., 2009). In their study on the associations between parenting behaviors, EC, and externalizing problems, Eisenberg and colleagues (2005) also found that the relation between warm parenting and low externalizing problems was mediated by EC. Similarly, Schatz, Smith, Borkowski, and Whitman (2008) found that high maternal CM risk predicted lower self-regulation in children at three years of age, which in turn predicted poorer academic and behavior outcomes two years later. Although these studies suggest that EC is affected by CM and IPV and that it can in turn affect other developmental outcomes, few studies have looked at how CM and IPV combine to influence EC outcomes.

Despite the risk FV confers on children's development of self-regulation, not all children exposed to FV have problematic outcomes (Cicchetti & Toth, 2005). It is not well understood as to why this individual variability exists, but one possibility is that individual differences in children's genetic polymorphisms may explain why some individuals are more adversely affected by exposure to FV than others. For example, genes involved in the dopaminergic and serotonergic systems have been implicated as having a role in regulation and in the development of behavior problems. The dopamine D4 receptor gene (DRD4) is part of the dopaminergic system, which is related to attention, motivation and reward-sensitivity (Bakermans-Kranenburg, van IJzendoorn, Pijlman, Mesman, & Juffer, 2008). Versions of the gene vary in the number of tandem repeats, and certain polymorphisms have been linked to low receptor efficiency (Belsky & Pluess, 2009).

Specifically, the 7-repeat of DRD4 has been associated with attachment disorganization and externalizing problems, like aggression, in children and novelty-seeking, impulsivity and substance abuse in adults (Bakermans-Kranenburg & van IJzendoorn, 2006; Bakermans-Kranenburg & van IJzendoorn, 2007; Schmidt, Fox, Perez-Edgar, Hu, & Hamer, 2001). Many studies have also found evidence that the long DRD4 allele and the 7-repeat allele (depending on how each study operationalizes the variable) are associated with ADHD with some researchers estimating that up to 50% of ADHD cases are associated with the 7-repeat allele (Johnson et al., 2008). Children with these risk alleles have scored significantly higher on attention problem scales than children without it, and even among non-clinical samples, DRD4 has been associated with a range of attention abilities (Schmidt et al., 2001).

Although there appears to be direct linkages between DRD4 and certain outcomes, there is mounting evidence that a person's genes actually interact with the environment to produce outcomes (Belsky & Pluess, 2009). Researchers have hypothesized that certain genetic factors make people more vulnerable to trauma or more susceptible to their environment. Both the dual-risk model and the diathesis-stress model theorize that certain phenotypic, endophenotypic, or genetic “risks” within the individual interact with environmental risk factors to confer pronounced vulnerability to the environment (Belsky & Pluess, 2009). Once these models were developed, they drove new studies of gene by environment interactions (G x E interactions), and the focus of these studies was on how, when exposed to environmental stressors, “vulnerable” individuals demonstrate significantly poorer outcomes than individuals without the risk alleles (Kim-Cohen & Gold, 2009). Refer to Figure 1 for data that would support the genetic vulnerability model.

Guided by research on attachment, Bakermans-Kranenburg and van IJzendoorn (2007) posited that Belsky’s differential susceptibility model fit the data better. Parallel to the models described above, the differential susceptibility model theorizes that in stressful environments, certain individuals are more likely than others to demonstrate poor outcomes (Belsky & Pluess, 2009). On the positive side, however, the differential susceptibility model suggests that when in an enriched environment, or one without the negative environmental factor in question, those same individuals fare better than others (Bakermans-Kranenburg & van IJzendoorn, 2007; Belsky & Pluess, 2009). This model theorizes that due to phenotypic, endophenotypic, or genetic factors, certain individuals are, in general, more susceptible to their environment, whether it is negative or positive. See Figure 2 for data that would support the differential susceptibility model.

Boyce and Ellis’s (2005) biological sensitivity to context model is similar to the differential susceptibility model in that it theorizes that certain individuals are more sensitive to both positive and negative environments. However, while Belsky's model emphasizes that characteristics inherent in certain individuals will result in increased susceptibility to their environment, Boyce and Ellis's model focuses on how environmental factors influence the development of either a more plastic or less plastic stress-response system (Belsky & Pluess, 2009; Boyce & Ellis, 2005). Although the differential susceptibility and biological sensitivity to context models have different theoretical foundations, both models predict similar results. Due to the current study's focus on how genes moderate outcomes and the recent shift towards using the different susceptibility model to investigate developmental outcomes (Ellis, Boyce, Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2011), this study was guided by that model.

DRD4 has received a lot of recent attention with regard to influencing an individual's susceptibility to his or her environment. In a research review, Belsky and Pluess (2009) summarized how DRD4 has been shown to interact with a variety of parenting and childhood experiences to influence the development of a variety of problematic outcomes. It has been consistently demonstrated that among children exposed to environmental stressors, the 7-repeat polymorphism or "long" allele (depending on how the variable was operationalized) predicts worse outcomes (Belsky & Pluess, 2009; Bakermans-Kranenburg & van IJzendoorn, 2007). For example, DRD4 interacts with maternal insensitivity to predict externalizing problems so that children with the 7-repeat polymorphism, compared to those without the polymorphism, show more externalizing problems when parents engage in insensitive parenting and fewer when parents use sensitive strategies (Bakermans-Kranenburg & van IJzendoorn, 2006). Among children without the polymorphism, parenting style has not been associated with a particular outcome (Bakermans-Kranenburg & IJzendoorn, 2006). Similarly, van IJzendoorn and Bakermans-Kranenburg (2006) found that only for infants with the 7-repeat polymorphism did unresolved maternal loss or trauma predict disorganized attachment. Sheese, Voelker, Rothbart, and Posner (2007) found that among children with the 7-repeat polymorphism, low quality parenting predicted more sensation seeking, but among children without the 7-repeat, parenting quality had no main effect on the same outcome.

In a unique test of the positive side of the differential susceptibility model, Bakermans-Kranenburg and colleagues (2008) demonstrated that an intervention designed to increase maternal sensitivity interacted with children's genotype to influence behavioral outcomes. Although children with the 7-repeat DRD4 allele entered the intervention with the most severe rates of externalizing problems, they ended the intervention with the lowest levels of externalizing problems, demonstrating that the intervention had the most profound positive effects on children with the 7-repeat allele (Bakermans-Kranenburg et al., 2008). This study provided valuable experimental evidence in support of the differential susceptibility model because, although other studies have documented a trend towards differential susceptibility, most studies have not found significant differences in individual outcomes in positive environments (Belsky & Pluess, 2009).

As described above, DRD4 has been shown to interact with environmental factors such as unresolved maternal loss/trauma (van IJzendoorn & Bakermans-Kranenburg, 2006) and parenting behaviors (Bakermans-Kranenburg & van IJzendoorn, 2006; Bakermans-Kranenburg et al., 2008; Sheese et al., 2007) in predicting a number of outcomes. These interactions studies have not, however, focused specifically on how CM, IPV, or combined FV interacts with DRD4. These studies also focus on behavior outcomes such as externalizing problems (Bakermans-Kranenburg & van IJzendoorn, 2006; Bakermans-Kranenburg et al., 2008) or on attachment (van IJzendoorn & Bakermans-Kranenburg, 2006). Only one study (Sheese et al., 2007) has looked at how EC was predicted by the interaction between DRD4 and the environment, and although it found no interaction, the environmental predictor was observer-rated parenting quality rather than FV. The specific interaction between DRD4 and FV in predicting EC has yet to be studied.

The Current Study

The first goal of the current study is to examine the effects of family violence and DRD4 on the effortful control outcomes of preschool-aged children. Based on previous literature suggesting that experiences of CM and IPV affect EC (e.g. Gustafsson et al., 2012; Robinson et al., 2008), it is expected that there will be a main effect for FV on children's EC. Specifically, children exposed to greater FV will perform poorer on EC when compared to children exposed to less FV. For DRD4, no main effect is predicted. On its own, DRD4 is not expected to relate to effortful control (e.g. Sheese et al., 2007; van IJzendoorn & Bakermans-Kranenburg, 2006).

The second goal of this study is to examine whether variations, specifically the 7-repeat polymorphism, in DRD4 moderate relations between exposure to FV and children's EC. In congruence with previous DRD4 x Environment interaction studies (e.g. Bakermans-Kranenburg & van IJzendoorn, 2006; Bakermans-Kranenburg et al., 2008) and consistent with the differential susceptibility hypothesis (Belsky & Pluess, 2009), it is hypothesized that, beyond the main effect of FV on children's EC, the 7-repeat genetic polymorphism will moderate those relations. Specifically, children with the 7-repeat allele will show the poorest EC when exposed to high levels of FV, but these same children will show the highest levels of EC when exposed to low levels of FV. For children without the 7-repeat polymorphism, the environment will not have a significant effect on EC scores.

Chapter 2

Method

Participants

The data used for this project were taken from a larger five-year National Institute of Mental Health-funded study examining parenting processes and the development of self-regulation in children (Skowron et al., 2011). Mothers and their preschool-age children were recruited from five rural counties in central Pennsylvania through Department of Public Welfare agencies, Child Protective Services (CPS), and a university-maintained database of birth announcements. Mothers were at least18 years of age, spoke fluent English, and had custody of the target child. To be included in the CM group, CPS records had to indicate that the mother was the perpetrator of CM. During recruitment, efforts were made to match CPS-involved families to non-CPS-involved families based on key demographics, such as socio-economic status and/or ethnicity.

The current project included 84 dyads (CM *N*= 40) for whom genetic data were available. Due to incomplete data for five children (see the family violence subsection within the measures section), the final sample included 79 children. Children ranged in age from 3-5 years old (*M* = 3.69, *SD*= .73 years) and 54.8% were female. In terms of child ethnicity, 77.4% were Caucasian, 3.6% were African American, and 17.9% were multiracial. Mothers ranged from 20-45 years old (*M* = 29.36, *SD* = 5.81 years), and 90.5% were Caucasian, 4.8% were African American, 1.2% were Asian, 1.2% were Hispanic/Latino(a), and 2.4% were multiracial. Mothers' years of education and ranged from 10-24 years (*M* = 13.74, *SD* = 2.74). Approximately 25.0% of mothers reported incomes less than $10,000; 42.9% between $10,001-30,000; 11.9% between $30,001-50,000; and 19.0% more than $50,001. In terms of relationship status, 42.9% of the mothers reported being married, 19.0% reported being single, 20.2% in a committed relationship, 3.6% as separated and 14.3% as divorced.

Procedures

After initial recruitment, children were deemed eligible for the study if the mother was not identified as a sexual perpetrator, if the child had no reported history of sexual abuse, if the mother scored above a 24 on the Mini-Mental Status Exam (Folstein, Folstein, & McHugh, 1975) and was not under the influence of any substances during the interview, and if neither the mother or child had a mental or physical disability that would limit participation in the study.

Dyads participated in three sessions: two home visits and one lab visit. Each visit lasted approximately 2-3 hours. During the home visits, a team of two trained interviewers went to the dyad's home and completed a number of psychosocial questionnaires, including a maternal assessment of interpartner violence, and demographic surveys with the mother, and both the mother and child completed cognitive assessments. The mother also gave consent for researchers to look at any available CPS records. During the laboratory visit, the dyad participated in a series of mother-child joint tasks while being video-audio recorded. The child also completed a series of individual effortful control tasks with one of the interviewers, including two Stroop-like procedures. In order to obtain the necessary genetic information, buccal cheek swabs were also obtained from the child with the mother's consent and the child's willing participation.

Measures

Family violence. In order to capture a range of violence exposure, this study used a total FV variable that was composed of both IPV and CM severity (Cipriano, Skowron, & Gatzke-Kopp, 2011). During the home visit, an interviewer worked with the mother to assess IPV using the revised Conflict Tactics Scale (CTS-R; Straus, 1979). This measure, which is composed of

19 items and takes about 10 minutes to complete, assesses strategies couples use to solve problems. Mothers filled out this measure based on their most recent, long-term relationship. For each item the mother is asked, "In the past 12 months, how many times have you…," and she rated how many times she used that problem-solving tactic on a scale of 1 (once) to 6 (more than 20). If she had never used that tactic, she was given a 0. Then, for the same item, she was asked, "In the past 12 months, how many times has your spouse/partner…," and she rated how many times her partner used that same strategy. If she said that neither she nor her partner used that tactic in the past 12 months (i.e. gives both herself and her partner a rating of 0), then she is asked, "Has this ever happened?" This she answered with either yes or no (Straus, 1979).

The CTS includes sub-scales on Verbal Aggression, Physical Violence, and Reasoning (Straus, 1979). For the present study, only subscale scores on the Verbal Aggression and Physical Violence scales were used to assess IPV. To get a rating of IPV, weighted frequency scores for the Verbal Aggression (*M* = 26.82; *SD* = 24.38; range = 0.00-104.00) and Physical Violence (*M* = 2.70*; SD* = 7.70*;* range = 0.00-56.50*)* subscales were calculated. Items were weighted according to frequencies indicted in the response categories presented to the mothers such that higher ratings on items were more heavily weighted (Cipriano et al., 2011).

During the informed consent process, the mother consented to researchers' access to and review of any available CPS records for her family, and the Maltreatment Classification System (MCS; Barnett, Manly, & Cicchetti, 1993) was used to score recorded incidents of CM exposure. The MCS rates CM exposure based on the subtype of CM, severity, frequency, and chronicity of CM exposure as well as the identity of the perpetrator and any out of home placements (Barnett et al., 1993). For this project, however, only CM severity was used. CM exposure was conceptualized as any perpetration of physical abuse, neglect, or emotional maltreatment against the child. An experienced research assistant was trained on a set of case records until the desired weighted reliability Kappa of .74 was achieved, and then this person was designated as the MCS coder. Each instance of CM exposure was given a severity rating ranging from 1 (mild) to 5 (severe) so that a higher rating indicated a more severe instance. In cases in which multiple instances of CM exposure were reported, each instance was scored, and the score for the most severe instance was the one that was used (Cipriano et al., 2011). CPS-involved families without a codable instance of CM exposure were not included in this study, and non-CPS-involved families were given a CM severity score of 0 (*N* = 44, 52.4%). The mean CM severity score was M=1.48 (SD=1.77; range=1-5).

To get a composite FV score, IPV and CM scores were standardized as z-scores and summed. Higher scores indicate greater levels of FV (Cipriano et al., 2011). Five children were missing an FV score because their mothers were not in relationships and could not fill out the CTS, leaving them with no IPV score.

Effortful control. Children's EC was assessed using scores on two modified Stroop tasks, the Shapes Task (Kochanska, Murray, Jaques, & Coy, 1997) and the Day/Night task (Gerstadt, Hong, & Diamond, 1994). During the Shapes task, the child had to ignore the prominent features of three pictures, instead attending to the cards' subdominant features in order to correctly identify the requested card. To begin the task, the interviewer put a picture of a big apple on the table, saying, "Look, I have a *big* apple." The word "big" was emphasized in a deep voice. Then the interviewer put a picture of a little apple beneath (closer to the child) that picture, saying, "And look, I have a *little* apple." Here, "little" was emphasized in a high voice. The interviewer did this process for the big and little orange and banana pictures. Once all 6 pictures were on the table in front of the child, the interviewer summarized by pointing in a sweeping motion along the top row of pictures saying, “Remember, these are *big.*” While pointing in a sweeping motion along the top row of pictures, he/she reminded the child “… and these are *little.*” Next, the interview removed the pictures of small fruit and confirmed that the child knew the name of each fruit by asking him/her to point to them (ex: “Show me the apple.”). If the child incorrectly identified a fruit, the interviewer corrected him/her and repeated the question. To start the actual test, the interview then flipped over the pictures. On the new side of the cards were pictures of small fruit embedded in a large fruit. The interviewer tested the child by asking him/her to point to the little fruit (ex: “Show me the *little* apple.”). If the child answered the first prompt incorrectly, the interviewer correct him/her by saying, “No, look, here is the *little, little, little* apple,” but this was the only correction the interviewer made for the rest of the task. The child received a score (*M*= 4.94, *SD*= 1.58, Range= 0.00-6.00) based on the number of pictures he/she correctly identified. This task is designed to assess a child’s attentional effortful control; higher scores indicate better effortful control (Kochanska et al., 1997).

After children completed the Shapes task, children participated in a second EC task, Day/Night (Gerstadt et al., 1994). The first two cards of the task were used to teach the child the protocol. The child was shown a picture of a moon and stars while the interviewer said, “When you see this card, you say day. Can you say day?” Then the child was shown a picture of a sun; “When you see this card, you say night. Can you say night?” After this, the test began, and the child was shown two more cards (one of each type). If the child did not respond right away, the interviewer prompted him/her asking, “What do you say when you see this card?” These first two test trials were “practice trials,” so if the child got them wrong, the interviewer reminded the child how to play. If the child got them correct, they counted towards the child’s score. After the practice trials, the interviewer continued the test with 14 more cards. The order of the cards was purposefully arranged to minimize the participants' ability to get an artificially high score by just alternating their response. No matter how the child did, the interviewer always ended the task by telling the child he/she did well and was going to get a prize. The children received a score (M=16.91, SD= 10.46, Range= 0.00-32.00) based on how many of the cards they responded correctly to; higher scores indicate better effortful control (Gerstadt et al., 1994).

Because scores on the Shapes and Day/Night task were positively correlated (r = .21, p = .07), an EC composite score was computed by standardizing and summing their scores on the two tasks. Higher scores indicated better effortful control. Eight children did not receive an EC score because they were missing a score for Shapes and/or Day/Night.

DRD4. Dopamine D4 Receptor gene, DRD4, is located on chromosome 11p15.5. In exon III, there are a variety of polymorphisms possible, which vary in the number of 48 base pair tandem repeats (Schmidt et al., 2001). Genetic DNA was prepared from buccal swabs; children's cheek cells were collected by rolling a buccal swab around the inside top and inside bottom of both cheeks (one swab for each region; 4 swabs total) for 10 seconds. If the child would not allow the interviewer to carry out this procedure, the mother was instructed on how to do it so that genetic data could still be collected. The swabs were kept in a lysis buffer until they were sent to the lab for analysis, at which point, the DRD4 exon III was amplified by the polymerase chain reaction. The number of repeats was determined by running the result through gel electrophoresis and ethidium bromide staining (Bakermans-Kranenburg & van IJzendoorn, 2006; Bakermans-Kranenburg et al., 2008).

As stated previously, some researchers have operationalized the DRD4 variable through allele length (i.e. long alleles vs. short alleles; e.g. Schmidt et al., 2001), while others have used the presence or absence of the 7-repeat allele (e.g. Bakermans-Kranenburg & van IJzendoorn, 2006*)*. In this study, the latter method was used. Children without a 7-repeat allele were coded as no 7-repeat (*N*=62, 73.8%), and children with at least one 7-repeat allele were coded as 7-repeat (*N* = 22, 26.2%).

Chapter 3

Results

Preliminary Analysis

Descriptives and intercorrelations between the study variable are shown in Table 1. Children exposed to more family violence performed poorer on effortful control tasks ($r = -.36$, $p = .002$). Additionally, analyses were conducted to determine whether there were differences on EC and FV in children with the DRD4 7-repeat and those without. Results revealed that children with the DRD4 7-repeat and those without did not differ on FV [$t(1,77) = -.688$, $p = .49$] or EC scores [$t(1,74) = 1.185$, $p = .24$].

The differences across child gender and age in relation to the study variables were also examined. FV was unrelated to child gender [$t(1,77) = -1.01$, $p = .31$] and child age ($r = .04$, $p = .75$). DRD4 was related to child gender [$\chi^2(1, N = 84) = 3.88$, $p = .05$]. Although there were similar numbers of girls ($M = 30$) and boys ($M = 32$) in the group without a 7-repeat allele, there were significantly more girls ($M = 16$) than boys ($M = 6$) in the group with at least one 7-repeat DRD4 allele. DRD4 was unrelated to child age [$t(1,82) = .07$, $p = .95$]. EC scores were unrelated to child gender [$t(1,74) = .64$, $p = .53$] but positively correlated with child age ($r = .39$, $p = .001$). Older children performed better than younger children on EC. Child age was included as a covariate in the regression model given its association with EC.

Primary Analysis

A hierarchical regression analysis was conducted to determine whether the relationship between FV and EC was moderated by DRD4 7-repeat allele. Before the analysis was conducted, the FV variable and child age (a covariate) were centered in order to eliminate the effects of multicollinearity. For the DRD4 variable, the group without a 7-repeat (no 7-repeat) was used as the reference, and the group with at least one 7-repeat (7-repeat) was used as the comparison group. An interaction variable, centered FV x DRD4, was also created. In the regression, centered child age was entered as the first step as a covariate, centered FV and DRD4 were entered in step two, and the FV x DRD4 interaction was entered as the final step. When a significant interaction was revealed, procedures recommended by Aiken and West (1991) were employed.

As shown in Table 2, the effect of child age was significant, $\Delta F(1,71) = 12.07$, $p = .001$. Older children performed better on EC compared to younger children. Next, the main effects of FV and DRD4 were tested in step 2 and a significant effect emerged, $\Delta F(2,69) = 8.59$, $p = .001$. Specifically, children exposed to greater levels of FV performed worse on the composite EC outcome, [$\beta = -.40$, $t(1,69) = -3.99$, $p = .001$]. However, there was no main effect of DRD4 on EC scores [$\beta = -.07$, $t(1,69) = -.70$, $p = .49$]. Finally, the interaction between FV x DRD4 was tested in the third step. As shown in the table, the interaction was not significant, $\Delta F(1,68) = .71$, $p = .40$.

Chapter 4

Discussion

The goals of the present study were two-fold. The first goal was to examine the effects of family violence and DRD4 polymorphisms on preschool children's effortful control outcomes. The second, and primary, goal was to examine whether the 7-repeat genetic polymorphism of DRD4 moderated the relationship between exposure to family violence and preschool children's effortful control outcomes. If a moderation effect was found, it was expected to support the differential susceptibility model of G x E interactions, such that children with the 7-repeat polymorphism would demonstrate greater susceptibility to both positive and negative environments (i.e., low and higher family violence exposure, respectively).

The first hypothesis was that children exposed to more family violence would perform more poorly on effortful control. This hypothesis was supported by the results, which showed that children exposed to higher levels of family violence had poorer effortful control. DRD4 was not expected to have a main effect on effortful control; on its own, DRD4 polymorphism would not predict effortful control scores. This too was supported by the data.

The finding of a main effect of family violence is consistent with the literature that suggests that experiences of child maltreatment (e.g. Alink et al., 2012; Gaensbauer, 1982; Wismer Fries et al., 2005) and interpartner violence (e.g. Davies & Cummings, 1994; Fantuzzo & Mohr, 1999) have a variety of negative effects. This finding is also consistent with the literature that has suggested that child maltreatment and interpartner violence separately affect effortful control (e.g. Gustafsson et al., 2012; Pollak et al., 2005; Robinson et al., 2009), which begins to develop rapidly in the preschool years (Kopp, 1982) and underlies many behavior problems and future pathology in individuals (e.g. Eisenberg et al., 2004; Eisenberg et al., 2009;

Obradovic, 2010). This finding extends that literature by taking into account the multiple pathways by which children may experience violence and by demonstrating that a combined variable is useful when investigating the effects of violence on effortful control. By demonstrating that exposure to high levels of family violence is correlated with poor effortful control in children, regardless of the genetic predisposition conferred by DRD4, this study demonstrates how family violence exposure can negatively impact a self-regulatory skill that plays a pivotal role in development.

Consistent with hypotheses, there was no relationship between DRD4 and effortful control scores. Although some of the literature had suggested a direct relationship between DRD4 and developmental outcomes such as attention (Schmidt et al., 2001), most studies have found no main effect of genetic polymorphism on developmental outcomes (Bakermans-Kranenburg et al., 2008; Bakermans-Kranenburg & van IJzendoorn, 2006), and this finding is consistent with that previous research.

However, it was hypothesized that the above main effects of family violence and DRD4 on children's effortful control would be further explained via an interaction between family violence and DRD4. It was predicted that the 7-repeat genetic polymorphism would moderate the effect of family violence on effortful control so that children with the 7-repeat polymorphism would be more susceptible to their environment. Among children exposed to high levels of family violence, children with the polymorphism would show the poorest effortful control; conversely, among children exposed to low levels of family violence, those with the polymorphism would show the highest effortful control. However, unlike most previous studies that found that DRD4 interacted with the environment (Bakermans-Kranenburg et al., 2008;

Bakermans-Kranenburg & van IJzendoorn, 2006; van IJzendoorn & Bakermans-Kranenburg, 2006), this study did not find evidence of an interaction.

There are several explanations as to why the present study did not find an interaction effect. Previous studies that found that the 7-repeat genetic polymorphism of DRD4 interacted with environmental factors differed from the current study in that the outcome they investigated was mother-reported levels of externalizing problems (e.g. Bakermans-Kranenburg & van IJzendoorn, 2006; Bakermans-Kranenburg et al., 2008) or attachment behavior (van IJzendoorn & Bakermans-Kranenburg, 2006). This study, on the other hand, focused on observer-reported effortful control. Importantly, this study also used a composite family violence score, which consisted of two significant forms of violence. It is possible that this powerful environmental factor could have overpowered any genetic or interaction effects. This finding was consistent, however, with the study that did specifically look at effortful control (Sheese et al., 2007), suggesting that environmental interactions with DRD4 are only visible when looking at the more overt outcomes that the majority of studies have used (Bakermans-Kranenburg et al., 2008; Bakermans-Kranenburg & van IJzendoorn, 2006; van IJzendoorn & Bakermans-Kranenburg, 2006).

Although this study suggests that childhood trauma results in poor effortful control, this study cannot show the pathway by which family violence affects effortful control. It is possible that constant exposure to family violence causes children to be hyper- or hypo-vigilant (Alink et al., 2012; Cicchetti & Toth, 2005; Mulvihill, 2005). Although this response may be adaptive in a violent context, it is maladaptive in the long-term; for example, it may leave these children “less able to utilize social contacts in ways which would facilitate their cognitive and social development” (Gaensbauer, 1982, p169). Alternatively, it is possible that children’s emotional security is decreased in environments with chronic violence (Davies & Cummings, 1994). It is also possible that parenting behavior moderates the relationship between family violence and effortful control. A study by Gustafsson, Cox, and Blair (2012) found that parenting fully mediated the effects of interpartner violence on children's effortful control. Family violence was associated with harsher, less sensitive parenting, while only sensitive parenting predicted effortful control (e.g. Gustafsson et al., 2012).

Future studies are needed to elucidate and unpack the mechanisms responsible for the linkages between family violence and effortful control because they could have important implications for mental health prevention and intervention. The findings from this study suggest that efforts to improve at-risk children's developmental outcomes should start with interventions that aim to reduce family violence. For example, interveners might work with couples to teach them effective, non-violent strategies for dealing with conflict and resolving problems, or they might with work parents on positive parenting strategies designed to reduce the level of violence directed at children.

In addition, more longitudinal studies (e.g. Eisenberg et al., 2009; Moffitt et al., 2010; Murray & Kochanska, 2022; Obradovic, 2010) that show how early regulatory abilities predict future childhood problems as well as long-term adult outcomes would be beneficial to researchers and practitioners trying to determine the best age at which to start interventions and what aspects of functioning to target.

More research is also needed to determine whether DRD4 plays a role in the development of regulation and whether it moderates the effects of family violence on other developmental outcomes. Replication is needed to determine whether an interaction can be seen when investigating other aspects of self-regulation or if it only becomes visible when more overt outcomes are measured. Also, it would be beneficial to look at how combinations of genes relate to outcomes. Some researchers (Cicchetti, Rogosch, & Toth, 2011) have begun to investigate the potential genetic risks conferred by specific combinations of “risky” alleles or genetic polymorphisms. These investigators have created genetic risk variables that are a composite of all the genetic risks conferred by each risk allele being studied; children with more of the risky genetic polymorphisms are compared to children with no risky alleles (Cicchetti et al., 2011).

In conclusion, this study suggests that although is it important to understand the role that both nature and nurture play in influencing an individual’s development, poor environments can have negative effects regardless of genetic predisposition. This kind of research is important because as researchers and practitioners continue to learn more about the genetic and environmental processes that impact development, more focused and successful interventions and treatments will be developed. Despite the risks conferred by exposure to family violence, it is not an immutable prescription for future dysfunction (Cicchetti & Toth, 2005), but researchers and practitioners must understand the underlying processes of trauma and how it influences development in order to help those who have experienced it.

References

Aiken, L. S., & West, S. G. (1991). *Multiple regression: testing and interpreting interactions.* Thousand Oaks, CA: Sage.

Alink, L. R. A., Cicchetti, D., Kim, J., & Rogosch, F. A. (2012). Longitudinal associations among child maltreatment, social functioning, and cortisol regulation. *Developmental Psychology, 48(1)*, 224-236. doi: 10.1037/a0024892

Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2006). Gene-environment interaction of the dopamine DR receptor (DRD4) and observed maternal insensitivity predicting externalizing behavior in preschoolers. *Developmental Psychobiology, 48*, 406-409. doi: 10.1002/dev.20152

Bakermans-Kranenburg, M. J., van IJzendoorn, M. H. (2007). Research review: genetic vulnerability or differential susceptibility in child development: the case of attachment. *Journal of Child Psychology and Psychiatry, 48(12)*, 1160-1173. doi: 10.1111/j.1469-7610.2007.01801.x

Bakermans-Kranenburg, M. J., van IJzendoorn, M. H., Pijlman, F. T. A., Mesman, J., & Juffer, F. (2008). Experimental evidence for differential susceptibility: dopamine D4 receptor polymorphism (DRD4 VNTR) moderates intervention effects on toddlers' externalizing behavior in a randomized controlled trial. *Developmental Psychology, 44(1)*, 293-300. doi: 10.1037/0012-1649.44.1.293

Barnett, D., Manly, J. T., & Cicchetti, D. (1993). Defining child maltreatment: the interface between policy and research. In D. Cicchetti & S. L. Toth (Eds.), *Child abuse, child development, and social policy*, 7-73. Norwood, NJ: Ablex.

Belsky, J., & Pluess, M. (2009). Beyond diathesis stress: differential susceptibility to environmental influences. *Psychological Bulletin, 135(6)*, 885-908. doi: 10.1037/a0017376

Boyce, W. T., & Ellis, B. J. (2005). Biological sensitivity to context: an evolutionary-developmental theory of the origins and functions of stress reactivity. *Development and Psychopathology, 17*, 271-301. doi: 10.1017/S0954579405050145

Cicchetti, D., & Toth, S. L. (2005). Child maltreatment. *Annual Review of Clinical Psychology, 1*, 409-438. doi: 10.1146/annurev.clinpsy.1.102803.144029

Cipriano, E. A., Skowron, E. A., & Gatzke-Kopp, L. M. (2011). Preschool children's cardiac reactivity moderates relations between exposure to family violence and emotional adjustment. *Child Maltreatment, 16(3)*, 205-215. doi: 10.1177/107755951 1 1 408887

Cummings, E. M., Iannotti, R. J., & Zahn-Waxler, C. (1985). Influence of conflict between adults on the emotions and aggression of young children. *Developmental Psychology, 21(3)*, 495-507.

Davies, P. T., & Cummings, E. M. (1994). Marital conflict and child adjustment: an emotional security hypothesis. *Psychological Bulletin, 116(3)*, 387-411.

Eisenberg, N., Spinrad, T. L., Fabes, R. A., Reiser, M., Cumberland, A., Shepard, S. A.,… & Murphy, B. (2004). The relations of effortful control and impulsivity to children's resiliency and adjustment. *Child Development, 75(1)*, 25-46.

Eisenberg, N., Valiente, C., Spinrad, T. L., Cumberland, A., Liew, J., Reiser, M…. & Losoya, S. H. (2009). Longitudinal relations of children's effortful control, impulsivity, and negative emotionality to their externalizing, internalizing, and co-occurring behavior problems. *Developmental Psychology, 45(4)*, 988-1008. doi: 10.1037/a0016213

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

Ellis, B. J., Boyce, W. T., Belsky, J., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2011). Differential susceptibility to the environment: an evolutionary-neurodevelopmental theory. *Development and Psychopathology, 23*, 7-28. doi: 10.1017/S0954579410000611

Fantuzzo, J. W., & Mohr, W. K. (1999). Prevalence and effects of child exposure to domestic violence. *The Future of Children, Special Issue: Domestic Violence and Children, 9(3),* 21-32. doi: 10.2307/1602779

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-Mental State." A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, 12(3), 189-198.

Gaensbauer, T. J. (1982). Regulation of emotional expression in infants from two contrasting caretaking environments. *Journal of the American Academy of Children Psychiatry, 21(2)*, 163-171. doi: 0002-7138/82/2102-0163

Gerstadt, C. L., Hong, Y. J., & Diamond, A. (1994). The relationship between cognition and action: performance of children 3 ½ - 7 years old on a stroop- like day-night test. *Cognition, 53(2),* 129-153. doi: 10.1016/0010-0277(94)90068-X

Gustafsson, H. C., Cox, M. J., & Blair, C. (2012). Maternal parenting as a mediator of the relationship between intimate partner violence and effortful control. *Journal of Family Psychology, 26(1),* 115-123. doi: 10.1037/a0026283

Holden, G. W. (2003). Children exposed to domestic violence and child abuse: terminology and taxonomy. *Clinical Child and Family Psychology Review*, *6(3)*, 151-160. doi: 10.1023/A:1024906315255

Johnson, K. A., Kelly, S. P., Robertson, I. H., Barry, E., Mulligan, A., Daly, M.,… & Bellgrove, M. A. (2008). Absence of the 7-repeat variant of the DRD4 VNTR is associated with drifting sustained attention in children with ADHD but not in controls. *American Journal of Medical Genetics Part B (Neuropsychiatric Genetics), 147B*, 927-937. doi: 10.1002/ajmg.b.30718

Kim-Cohen, J., & Gold, A. L. (2009). Measured gene-environment interactions and mechanisms promoting resilient development. *Current Directions in Psychological Science, 18(3)*, 138-142. Retrieve from cdp.sagepub.com

Kochanska, G., Coy. K. C., & Murray, K. T. (2001). The development of self-regulation in the first four years of life. *Child Development*, *72(4)*, 1091-1111.

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

Kochanska, G., Murray, K., & Jacques, & Coy, K. C. (1997). Inhibitory control as a contributor to conscience in childhood: from toddler to early school age. Child Development, 68, 264-277. doi:10.2307/1131849

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

Moffitt, T. E., Arseneault, L., Belsky, D., Dickson, N., Hancox, R. J., Harrington, H.,… & Caspi, A. (2010). A gradient of childhood self-control predicts health, wealth, and public safety. *PNAS Early Edition*, 1-6. doi: 10.1073/pnas.1010076108

Mulvihill, D. (2005). The health impact of childhood trauma: an interdisciplinary review, 1997-2003. *Issues in Comprehensive Pediatric Nursing, 28*, 115-136. doi: 10.1080/01460860590950890

Murray, K. T., & Kochanska, G. (2002). Effortful control: factor structure and relation to externalizing and internalizing behaviors. *Journal of Abnormal Child Psychology, 30(5),* 503-514.

Obradovic, J. (2010). Effortful control and adaptive functioning of homeless children: variable-focused and person-focused analysis. *Journal of Applied Developmental Psychology*, *31*, 109-117. doi: 10.1016/j.appdev.2009.09.004

Pennsylvania Coalition Against Domestic Violence. (2012). Child witness. *Pennsylvania Coalition Against Domestic Violence.* Retrieved from http://www.pcadv.org/Domestic-Violence-Information-Center/Children-and-Teens/Child-Witness.asp.

Pollak, S. D., Vardi, S., Putzer Bechner, A. M., & Curtin, J. J. (2005). Physically abused children's regulation of attention in response to hostility. *Child Development, 76(5),* 968-977.

Robinson, L. R., Morris, A. S., Heller, S. S., Scheeringa, M. S., Boris, N. W., & Smyke, A. T. (2009). Relations between emotion regulation, parenting, and psychopathology in young maltreated children in out of home care. *Journal of Child and Family Studies, 18,* 421-434. doi:10.1007/s10826-008-9246-6

Rogosch, F. A., Dackis, M. N., & Cicchetti, D. (2011). Child maltreatment and allostatic load: consequences for physical and mental health in children from low-income families. *Development and Psychopathology, 23,* 1107-1124. doi: 10.1017/S0954579411000587

Rothbart, M. K., Sheese, B. E., & Posner, M. I. (2007). Executive attention and effortful control: linking temperament, brain networks, and genes. *Child Development Perspective, 1(1),* 2-7.

Rothbart, M. K., Sheese, B. E., Rueda, M. R., & Posner, M. I. (2011). Developing mechanisms of self-regulation in early life. *Emotion Review, 3(2),* 207-213. doi: 10.1177/1754073910387943

Schatz, J. N., Smith, L. E., Borkowski, J. G., Whitman, T. L., & Keogh, D. A. (2008). Maltreatment risk, self-regulation, and maladjustment in at-risk children. *Child Abuse & Neglect, 32,* 972-982. doi: 10.1016/j.chiabu.2008.09.001

Schmidt, L. A., Fox, N. A., Perez-Edgar, K., Hu, S., & Hamer, D. H. (2001). Association of DRD4 with attention problems in normal childhood development. *Psychiatric Genetics, 11(1),* 25-29.

Sheese, B. E., Voelker, P. M., Rothbart, M. K., & Posner, M. I. (2007). Parenting quality interacts with genetic variation in dopamine receptor D4 to influence temperament in early childhood. *Development and Psychopathology, 19,* 1039-1046. doi: 10.1017/S0954579407000521

Skowron, E. A., Loken, E., Gatzke-Kopp, L. M. Cipriano-Essel, E. A., Woehrle, P. L, Van Epps, J. J…. & Ammerman, R. T. (2011). Mapping cardiac physiology, parenting, and dyadic processes in maltreating mother-child dyads. *Journal of Family Psychology, 25*

Straus, Murray A. (1979). Measuring intrafamily conflict and violence: the conflict tactics (CT) scales. *Journal of Marriage and the Family, 41*, 75-88.

van IJzendoorn, M. H., & Bakermans-Kranenburg, M. J. (2006). DRD4 7-repeat polymorphism moderates the association between maternal unresolved loss or trauma and infant disorganization. *Attachment & Human Development, 8(4),* 291-307. doi: 10.1080/14616730601048159

Wismer Fries, A. B., Ziegler, T. E., Kurian, J. R., Jacoris, S., & Pollak, S. D. (2005). Early experience in humans is associated with changes in neuropeptides critical for regulating social behavior. *PNAS, 102(47)*, 17237-17240. doi: 10.1073/pnas.0504767102

Appendix A

Tables

Table 1. *Descriptives and Intercorrelations for Study Variables*

	1	2
1.[a]Family Violence (FV)	--	
2.[b]Effortful Control (EC)	-.36**	--
M	-.03	.13
SD	1.62	1.51
Range	-1.84-4.11	-4.20-2.14

Note. ***p* < .01.
M = Mean. *SD* = Standard Deviation.
[a]Sum of standardized scores on CM and CTS. [b]Sum of standardized scores on Shapes and Day/Night tasks.

Table 2. *Standardized Regression Coefficients for Analyses Testing the Effect of the Interaction between DRD4 and Family Violence on Effortful Control*

	B	*SE(B)*	β	ΔR^2
Step 1				.15**
Child Age	.82**	.24	.381	
Step 2				.17**
Family Violence	-.37**	.09	-.40	
DRD4	-.25	.35	-.07	
Step 3				.00
Family Violence x DRD4	-.17	.20	-.10	
Total				.32

Note. ***p* < .01.
B = unstandardized beta coefficient. *SE(B)* = standard effort of unstandardized beta coefficient. β = standardized beta coefficient. ΔR^2 = *R* square change value.

Appendix B

Figures

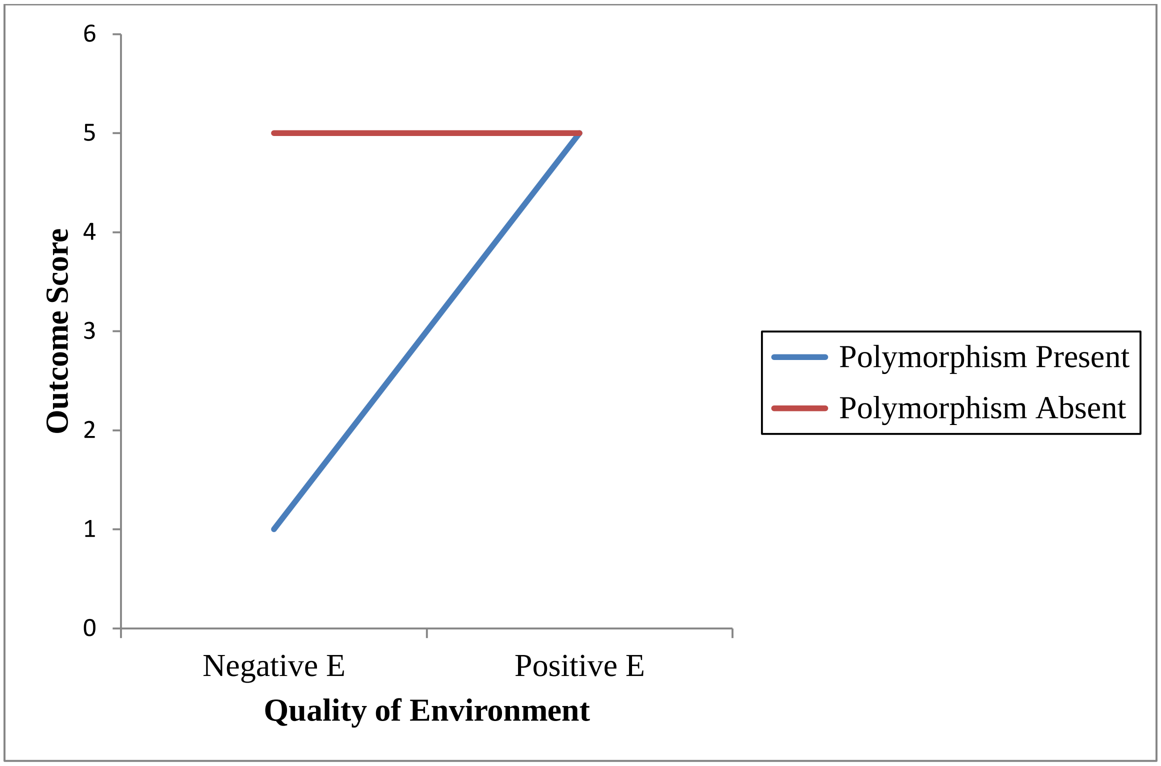

Figure 1. The data trends that would be expected if the data fit the genetic vulnerability model of G x E interactions. Higher outcome scores indicate a more positive outcome. G = gene, E = environment.

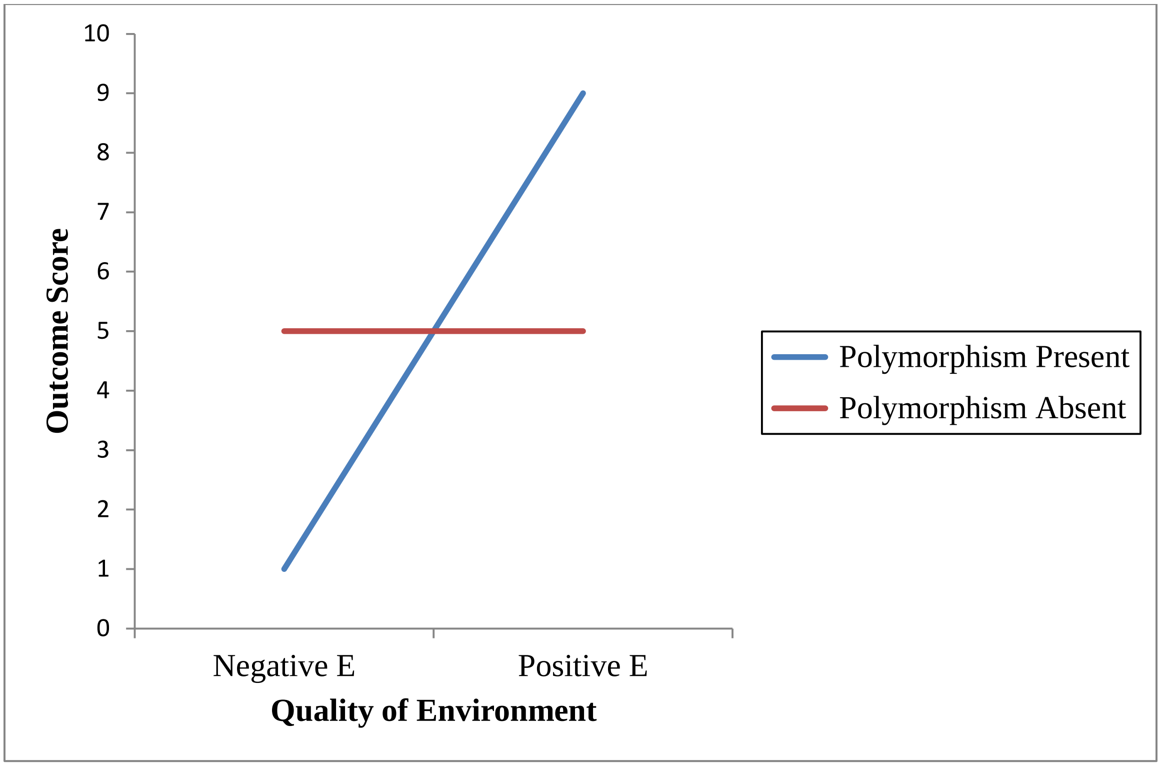

Figure 2. The data trends that would be expected if the data fit the differential susceptibility model of G x E interactions. Higher outcome scores indicate a more positive outcome. G = gene, E = environment.

ACADEMIC VITA of Catherine M. L. Leece

Catherine M. L. Leece
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Education: Bachelor of Science Degree in Psychology, Pennsylvania State University, Spring 2012
Concentration in Business
Honors in Educational Psychology
Coursework in Spanish, Special Education, and Women's Studies
Study Abroad, National University of Singapore, Fall 2009
Thesis Title: Does DRD4 Moderate the Effects of Family Violence on Children's Regulatory Outcomes?
Thesis Supervisor: Elizabeth A. Skowron

Related Experience:
Research assistant at The FaMILY Study, Fall 2010-Fall 2011
Supervisors: Angie Morrison, Jessica Villanueva, Dr. Elizabeth Skowron
Friendship Group coach, Fall 2011-Spring 2012
Supervisor: Dr. Janet Welsh

Employment/Internships:
Center County Women's Resource Center Overnight/Weekend Counselor, Fall 2011-present
Supervisor: Kathleen Stehouwer
Internship at the Starfinder Foundation (completed independent project in behavior analysis and management), Summer 2010
Supervisor: Stephen Jackson
Internship at the Starfinder Foundation (soccer coach and classroom teacher), Summer 2009
Supervisor: Heidi Warren

Teaching/Certifications:
Intern teacher and science department head at the Breakthrough Collaborative, Summer 2011
Supervisor: Craig Saslow
Domestic and Sexual Violence Counselor/Advocate, Spring 2011- present
PHREE (women's education and empowerment group) Peer Educator, Fall 2010- present
Supervisor: Jennifer Sharp

Awards: Dean's List
Schreyer Honors College Scholarship
Summer Discovery Grant, Summer 2011
Summer Internship Grant, Summer 2009, Summer 2010
Schreyer Travel Grant, Fall 2009

Presentations/Activities:
Presented poster at Psi Chi Research Conference, March 2011
Volunteer on Center County Women's Resource Center hotline, Spring 2011, Summer 2011
Supervisor: Meredith Hall
Gave behavior management trainings to staff during internship at the Starfinder Foundation, Summer 2010