THE ROLE OF EXECUTIVE FUNCTIONS AND MATERNAL CHARACTERISTICS IN EXTERNALIZING PROBLEMS AMONG YOUNG CHILDREN

by

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Abstract

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Externalizing problems, such as hyperactivity, inattention, and defiance, that emerge early in life put children on a path toward numerous adverse outcomes, including delinquency, academic failure, and substance abuse. Using a family study design, the current investigation sought to identify predictors of externalizing problems in preschool-aged children, with a specific focus on early executive functioning skills and maternal depression and education. Families with two children between the ages of 2.5 and 5.5 were recruited from the Dallas/Fort-Worth Metroplex and participated in a lab visit at The University of Texas at Arlington. The current study included 196 children (males = 102; mean age = 45.93 months, *SD* = 12.40) and their mothers (mean age = 34.13, *SD* = 5.13). Early executive functioning, specifically inhibitory control, predicted externalizing problems. Furthermore, maternal depression symptoms were positively related to children's externalizing problems, particularly among mothers with higher levels of education. Future research should examine the potentially positive impact of increasing inhibitory control on lowering child externalizing problems.

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Chapter 1

Introduction

Early-emerging externalizing problems, including impulsivity, defiance, and aggression, put children at risk for specific psychopathological conditions such as attention-deficit hyperactivity disorder (ADHD), oppositional defiant disorder (ODD), and conduct disorder (CD) (Campbell, 1995; Lynam, 1996). These disorders are associated with a host of negative long-term outcomes, such as academic failure, juvenile delinquency, substance abuse, antisocial behavior, physical health problems, and difficulties in marriage and employment (Bussing, Mason, Bell, Porter, & Garvan, 2010; Fergusson & Horwood, 1998; Fergusson & Lynskey, 1998; Hinshaw et al., 2012; Mannuzza & Klein, 2000; Mannuzza, Klein, Bessler, Malloy, & LaPadula, 1993). Identifying the early factors contributing to these disorders could inform possible prevention and intervention programs. Executive functioning, defined as goal-directed cognitive processing, has been identified as a critical regulator of behavior problems, but relatively few studies have examined this relationship during the preschool years (Brocki & Bohlin, 2006; Brocki, Eninger, Thorell, & Bohlin, 2010; Hughes & Ensor, 2009). Parental factors, such as maternal depression and maternal education, have also been linked to behavior problems (Caspi et al., 2004; Chronis et al., 2007; Goodman et al., 2011; Turney, 2012). In the context of a family study design, the current investigation aimed to identify both child-level and family-level predictors of early-developing attention and aggression problems.

Broadly speaking, externalizing problems decrease between the ages of 2 and 9 (Miner & Clarke-Stewart, 2008). The sharpest decrease in externalizing behaviors occurs from 2 to 7 years, with a more gradual decrease from 7 to 9 years, suggesting children learn to better control their attention, disobedience, and aggression upon entering school

(Miner & Clarke-Stewart, 2008; Shaw, Gilliom, Ingoldsby, & Nagin, 2003). Many preschool-aged children display attention and aggression problems, but even among typically-developing young children, there is substantial variation in the extent to which children display externalizing behavior (Bongers, Koot, van der Ende, & Verhulst, 2003). For a small number of high externalizers, the decrease in externalizing problems in early childhood is substantially more gradual (Miner & Clarke-Stewart, 2008; Shaw et al., 2003). Moreover, other evidence suggests that high levels of externalizing problems displayed early in life, particularly aggression, tend to be highly stable, especially among males (Shaw et al., 2003). Therefore, one aim of the current investigation was to examine the effect of age on externalizing problems.

Early-emerging high attention problems put children at risk for developing disorders such as ADHD. ADHD is one of the most common childhood psychiatric disorders affecting approximately 4% to 12% of school-aged children (Biederman & Faraone, 2005; Faraone, Sergeant, Gillberg, & Biederman, 2003; Rowland, Lesesne, & Abramowitz, 2002). ADHD symptoms are divided into two categories of hyperactivity/impulsivity and inattention that include behaviors such as excessive talking, inability to remain seated, fidgeting, failure to pay close attention to details, and difficulty organizing tasks and activities (5^{th} ed.; *DSM-5*; American Psychiatric Association, 2013). Children with ADHD have more difficulty with family and peer relationships, problems in learning and missing school, and exhibit more mental and physical health problems (Barkley, 1997; Bussing et al., 2010; Hinshaw et al., 2012; Mannuzza & Klein, 2000). Even children with sub-threshold ADHD show significant impairments, including social difficulties and academic failure (Bussing et al., 2010). Treatment of hyperactivity and attention problems in young children with medication has dramatically risen in recent years and is widely controversial (Castle, Aubert, Verbrugge, Khalid, & Epstein, 2007).

Therefore, identifying the early predictors of ADHD could inform prevention efforts in order to potentially reduce the number of children using medication as a treatment for attention problems.

ADHD is frequently comorbid with other disruptive behavior disorders, including ODD and CD (see Loeber, Burke, Lahey, Winters, & Zera, 2000 for review). ODD is characterized by a consistent pattern of uncooperative, defiant, and hostile behavior toward authority figures (5th ed.; *DSM-5*; American Psychiatric Association, 2013) and is one of the most common reasons children are referred to mental health clinics (Lavigne, LeBailly, Hopkins, Gouze, & Binns, 2009). ODD that emerges in the preschool period is highly stable, with approximately 80% of diagnosed preschoolers continuing to meet criteria for ODD three years later (Keenan et al., 2010). ODD frequently co-occurs with CD, but these disorders are distinguishable from one another (Loeber et al., 2000). The essential features of CD are a persistent pattern of violation of the basic rights of others and age-appropriate societal norms (4th ed.; DSM-IV; American Psychiatric Association, 1994). One theory of disruptive behavior disorders hypothesizes that only children with ADHD and comorbid ODD will go on to develop CD in childhood (see Loeber et al., 2000). Thus, early-emerging symptoms of ADHD and ODD may be predictive of later CD diagnosis. Most studies of ODD and CD rely on clinically referred samples, so the rate of symptoms in typically developing preschoolers is currently unknown (Keenan & Wakschlag, 2004). A recent study by Lavigne et al. (2009), however, reported a rate of 13.4% for ODD in a community sample of 4-year-olds without regard to impairment. Children who develop these disruptive behavior problems in the preschool years are at high risk for continuing on a trajectory toward further negative outcomes, such as delinquency and interpersonal violence during the teenage years (Fergusson & Horwood, 1998; Fergusson & Lynskey, 1998). Given the relationships between these behavior

disorders and numerous adverse outcomes, identifying early-emerging predictors of externalizing problems could potentially lead to prevention initiatives during the early preschool years.

1.1 Executive Functioning and Externalizing Problems

Many very young children have trouble regulating their attention and aggression, but these problems typically decrease throughout the preschool years. This time period coincides with the rapid development of cognitive skills, namely executive functioning, needed to regulate behaviors and emotions. Executive functions (EFs) are a family of control processes that are essential for thinking, concentrating, and planning. Researchers generally agree upon three core EFs: working memory, inhibitory control, and cognitive flexibility (see Diamond, 2013 for review). From these core EFs, higher-order functions, such as reasoning and problem solving, emerge (Lunt et al., 2012); and these higher-level functions are equivalent to fluid intelligence (Diamond, 2013).

Of the core EFs, working memory is the first to appear, typically emerging around the end of the first year of life (Diamond, 1995), and involves holding perceptually absent information in mind and mentally manipulating it (Baddeley & Hitch, 1994). Working memory is vital for the functioning of inhibitory control, which involves controlling one's thoughts, attention, behavior, and/or emotions in order to override a strong impulse or external temptation (Diamond, 2013). Although various types of inhibitory control exist (e.g. inhibition of thoughts and memories, inhibition at the level of attention), this study focused on inhibition at the level of behavior, which includes control over one's behavior and emotions (Diamond, 2013). Inhibitory control (IC) requires resisting temptations and not acting impulsively. In laboratory assessments of IC, children are asked to give a different response rather than an automatic response (e.g. saying the word 'day' when a moon is shown; Gerstadt, Hong, & Diamond, 1994). IC can also be assessed by the

ability to delay gratification--that is, resisting an immediate reward in order to receive a larger reward later (Prencipe & Zelazo, 2005). Typically, assessing a child's ability to override an automatic response occurs in an emotionally 'cool' situation, whereas assessing the ability to delay gratification occurs in an emotionally 'hot' situation where one has choices of delicious snacks and various toys (Beck, Schaefer, Pang & Carlson, 2011). As one can imagine, recent research has pointed to the idea that these two forms of IC (i.e. overriding a dominant response vs. delaying gratification) may have distinct relationships to concurrent and later functioning. Preschoolers who performed better on a 'cool' measure of IC demonstrated higher academic achievement and higher verbal mental age, but no such relations were found with 'hot' IC tasks (Brock, Rimm-Kaufman, Nathanson, & Grimm, 2009). Moreover, Beck et al. (2011) found 'hot' delay tasks showed little change across age, but much more variability within each age, suggesting that delay IC could be a more informative individual-differences measure of self-control at any age. It is critical to differentiate these two forms of IC, because EF researchers have historically focused on emotionally 'cool' tasks that are far removed from the real world. These tasks require involvement of the lateral prefrontal cortex, including dorso- and ventrolateral prefrontal areas (Diamond, 2013). 'Hot' EF tasks, on the other hand, substantially overlap with self-regulation (i.e. controlling one's emotions) and may rely more on medial prefrontal cortex, especially orbitofrontal cortex (Diamond, 2013). Therefore, it can be reasonably expected that these two forms of inhibition would show distinct relationships with other variables such as age, verbal ability, attention and aggression. Importantly, however, these two dimensions of IC are proposed to be a part of a single, interactive system that underlies and supports executive functioning (Beck et al., 2011).

Poor EFs are associated with worse physical health, including obesity and substance abuse, less success keeping a job, more difficulties in marriage, and more social problems, including violence and emotional outbursts (Bailey, 2007; Baler & Volkow, 2006; Diamond, 2005; Miller et al., 2011; Penades et al., 2007). EFs are more predictive of school readiness than IQ or reading and math skills and they predict math and reading competence throughout the school years (Blair & Razza, 2007). Even when measured under the age of 5, children with better self-control have better physical and mental health, earn more money, and commit fewer crimes as adults (Moffitt et al., 2011). Importantly, it has been demonstrated that EFs can be improved, especially at a young age (Diamond & Lee, 2011). Activities that have been shown to improve EFs include Taekwondo traditional martial arts, CogMed computerized training, Tools of the Mind and Montessori early childhood curriculum, and two add-ons to school curricula, Promoting Alternative Thinking Strategies (PATHS) and the Chicago School Readiness Project (CSRP) (for a review, see Diamond & Lee, 2011 and Diamond, 2013). Thus, given the fact that EFs can be improved, demonstrating a relationship between EFs and early-emerging externalizing problems would lend support for the idea that increasing EFs would decrease externalizing problems.

Externalizing problems have consistently been linked to poor executive functioning in older children and adults (Bohlin, Eninger, Brocki, & Thorell, 2011; Nigg, Quamma, Greenberg, & Kusche, 1999; Riggs, Blair, & Greenberg, 2003; Utendale & Hastings, 2011). In fact, the guiding theory of the neuropsychological underpinnings of ADHD is a disruption in executive functioning (Barkley, 1997). However, studies of executive functioning in very young children are relatively new, due to the fact that, historically, it was thought that young children lacked executive control. As a result, there are few developmentally appropriate measures available to assess EF and, additionally,

results of studies examining EF in young children tend to be inconsistent. Inconsistencies may arise from the manner in which EFs are defined and measured by the researcher, such as using a 'cool' IC task rather than a 'hot' IC task. Furthermore, there are inconsistent findings with respect to gender and executive functioning. Some studies have found gender differences in inhibition, but not working memory (Carlson & Wang, 2007), and yet others have found no gender differences at all (Hughes & Ensor, 2009). Therefore, it is very important to contribute to this literature in order to help elucidate these inconsistencies.

In sum, poor EFs are related to both concurrent externalizing problems in childhood as well as various negative adult outcomes. Given these important relationships, as well as the critical fact that EFs can be improved at a young age, demonstrating a strong link between EF and concurrent behavior problems in very young children could highlight the importance of increasing EFs early in life. Raising EF skills could potentially decrease behavior problems in very young children.

1.2 The Role of Gender in Externalizing Problems

Along with executive functioning, gender plays a distinct role in the development of externalizing problems. Typically, boys tend to express more externalizing problems than girls (Baillargeon et al., 2012). Previous research by Baillargeon et al. (2007) on children 17 months of age found that boys were more likely than girls to be distracted, restless, and hyperactive as well as fidget, kick, bite, and hit other children. In this study, 5% of boys demonstrated physical aggression on a frequent basis, while only 1% of girls demonstrated physical aggression. The most common type of aggression in the preschool years are conflicts over possessions, in which the child is motivated to obtain a concrete goal. While boys may use physical aggression to obtain a goal, there is

evidence to suggest that girls use relational aggression instead (e.g. excluding other children from a play activity), even in the preschool years (Crick, Casas & Moser, 1997).

On the other hand, other investigations of externalizing problems in preschoolers have revealed no gender differences (Keenan & Shaw, 1994). Loeber et al. (2000) suggested that differences in rates of externalizing problems between boys and girls may not emerge until around age 5. Parents may play a role in gender differences in later childhood, in that parents generally disapprove of externalizing problems in both boys and girls, but are, after the preschool years, more tolerant of externalizing problems in boys (Martin & Ross, 2005). Moreover, teachers may report more externalizing problems for boys, because boys tend to overtly express attention and aggression problems.

With regard to psychopathology, boys show higher rates of diagnoses of behavior problems than girls (Loeber et al., 2000). However, a disproportionate amount of research has been devoted to males rather than females. Of the limited research involving girls, Biederman, Faraone, & Monuteaux (2002) found that girls diagnosed with ADHD were more likely than boys to have a higher rate of predominantly inattentive type (although the combined type was the leading type in both genders) and a lesser likelihood to manifest problems in school or in their spare time. While it is apparent that more boys are being diagnosed with ADHD than girls, Coles et al. (2012) argued that the prevalence rates are dependent on whether the sample is drawn from clinical or population-based settings. Clinical samples (i.e. referred children) find prevalence ratios as much as 9:1, while population-based samples find that boys are only two to three times more likely than girls to develop ADHD. This indicates that boys are being referred disproportionately more often than girls and that only the most impaired girls are being referred. This may be due to the fact that adults, particularly teachers, tend to have more trouble with children who display behaviors that are overtly hyperactive and disruptive.

Therefore, adults may report higher problems for boys simply because they are more readily apparent. Because parents and teachers tend to report more problems in boys, the executive functioning of boys may not have the same effect on adult-reported externalizing problems as it does in girls. Specifically, adults may report high externalizing problems for boys even when they have high cognitive functioning. Thus, the current investigation tested whether boys showed higher externalizing problems regardless of executive functioning.

1.3 Verbal Ability and Externalizing Problems

Impairments in verbal ability are commonly observed among children with behavior problems (Cohen et al., 2000; Speltz, DeKlyen, Calderon, Greenberg, & Fisher, 1999). Verbal skills enable young children to think and talk about emotions that may lead to better self-control and, ultimately, decreased problem behaviors. Thus, the link between verbal ability and behavior problems could be explained by the rapid development of cognitive skills during the early years of life. Consistent with this view, Hughes & Ensor (2008) found that executive functioning at age 3 fully mediated the relationship between verbal ability at age 2 and problem behaviors at age 4. Thus, the present investigation examined the effect of verbal ability on both attention and aggression problems. Although not examined in the current study, the relationships found between verbal ability and externalizing problems would likely be due to increased cognitive functioning.

1.4 Maternal Factors associated with Child Externalizing Problems

Among maternal characteristics affecting externalizing problems, maternal depression and maternal education have frequently been cited in the literature (Chronis et al., 2007; Caspi et al., 2004; Hughes & Ensor, 2009). The negative relationship between maternal depression and problem behaviors has been demonstrated many

times (Chronis et al., 2007; Goodman et al., 2010; Knox, Burkhart, & Khuder, 2011). Depression is characterized by symptoms of fatigue, difficulties in concentration, and loss of interest in daily activities, which may all limit a mother's ability to provide her children with necessary resources (Turney, 2012). Maternal depression is accompanied by increased maternal negativity and reduced maternal warmth, which, even when accounting for genetic influences, predict child behavior problems (Caspi et al., 2004). When children are on the receiving end of negativity and decreased warmth, they become less compliant and more demanding. Given this evidence, the current investigation examined the effect of maternal depression symptoms on child externalizing problems.

Another maternal characteristic affecting behavior problems in children is education level. Maternal education has a complex association with child externalizing problems, because lower maternal education is associated with multiple other risk factors including single and teen parenthood, maternal stress, and low-quality childcare (Hughes & Ensor, 2009). Nevertheless, evidence suggests a direct association between maternal education and externalizing problems (NICHD Early Child Care Research Network, 2004). Children of mothers with low education tend to show more social, emotional, and behavior problems than children of mothers with higher education levels.

Although direct effects of maternal characteristics exist, the relationships can also be mediated by other characteristics within the child. Executive functioning has been implicated as a mediator between maternal characteristics and child outcomes (Hughes & Ensor, 2009). Previous research has demonstrated that executive functioning mediated the relationship between maternal depression and behavior problems (Hughes & Ensor, 2009). Therefore, the current study addressed the direct and indirect effects of maternal depression and maternal education on childhood externalizing problems. Providing

further evidence for the mediating role of executive functioning in these relationships would lend more support for increasing child executive functioning in order to prevent negative behavioral outcomes.

1.5 Siblings and Externalizing Problems

Siblings play a vital role in each other's adjustment and the similarity of siblings' developmental trajectories provides researchers with a unique opportunity to explain this phenomenon. While parenting and within-child variables are crucial predictors of child outcomes, the sibling subsystem can form a distinctive context within families that can influence child development (Bullock & Dishion, 2002). In studies controlling for parent-child and peer relationships, genetic factors, as well as parent factors, sibling characteristics still accounted for significant amounts of variance in child outcomes (Kim, McHale, Crouter, & Osgood, 2007; Rende, Slomkowski, Lloyd-Richardson, Niaura, 2005; Snyder, Bank, & Burraston, 2005). Lewin, Hops, Davis, & Dishion (1993) found a moderately high level of covariation among 45 pairs of elementary school-aged siblings for teacher ratings of social behavior on the playground, school adjustment, and academic competence. Moreover, several studies have suggested similarity among siblings in levels of delinquency and substance use (Rende et al., 2005; Snyder et al., 2005).

Sibling similarity that is unaccounted for by genetics, parenting, and peer relationships may result from processes of collusion and/or coercion (Snyder et al., 2005). In the collusion model, siblings co-participate in deviant activities that may strengthen similarity in disruptive behavior over time. This co-participation may later reinforce a wider variety of behavior problems. In the coercion model, children are exposed to their siblings' coercive interactions both by direct contact with them and by witnessing their siblings' interactions with their parents. Thus, children may exhibit

coercive behavior as a result of direct practice with their sibling and/or imitation of their siblings' coercive behaviors. Consequently, siblings may appear more similar in externalizing problems when, in reality, one sibling may be a much higher externalizer than the other. However, both processes work to reinforce disruptive behavior over time regardless of one child's initial proneness to externalizing problems.

While the current study did not assess the sibling relationship in detail, the family study design did allow for investigation of the relationship between one sibling's characteristics (e.g. inhibitory control) and the other sibling's externalizing problems. To my knowledge, no such investigation has taken place, especially in very young children. While there would undoubtedly be moderating and mediating factors in this relationship, such as coercive interactions discussed above, demonstrating a relationship between the inhibitory control of one sibling and externalizing problems of the other would highlight the importance of the sibling subsystem. It would also, again, support the idea of increasing executive functions at a young age. If this relationship exists, increasing inhibitory control in one sibling could potentially decrease externalizing problems in the other sibling.

1.6 The Current Study

Using a family study design, the current study sought to identify child-level and family-level predictors of early-emerging externalizing problems. At the child level, this investigation focused on early executive functioning skills, gender, age, and verbal ability as predictors of externalizing problems. At the family level, I examined maternal depression symptoms and maternal education as predictors of externalizing problems. A family design allows for assessing sibling relatedness of all child-level variables. Moreover, this design allowed for the analysis of the effects of one sibling's inhibitory control on the other sibling's behavior problems. As such, there were four specific hypotheses.

1.6.1 Hypothesis 1

The first hypothesis proposed that child executive functioning, gender, age, verbal ability, maternal depression, and maternal education would be significant predictors of externalizing problems. I expected that children with low executive functioning, low verbal ability, and younger age would show significantly greater levels of externalizing problems. I also expected gender to predict externalizing problems, in which young boys would have more problems than young girls. Lastly, I predicted high maternal depression symptoms and low maternal education to be significantly associated with greater levels of child externalizing problems.

1.6.2 Hypothesis 2

The second hypothesis proposed that gender would moderate the relationship between early executive functioning and externalizing problems. Specifically, I expected girls to show a stronger negative relationship between executive functioning and externalizing problems than boys. That is, girls and boys with low levels of executive functioning would have similarly high levels of externalizing problems, but boys with high executive functioning would show greater problems than girls with equally high executive functioning.

1.6.3 Hypothesis 3

The third hypothesis proposed that the effects of maternal depression symptoms and education on child externalizing problems would be mediated by child executive functioning (Figure 1-1). I expected that greater maternal depression symptoms and lower maternal education would negatively affect child executive functioning. Child executive functioning would then affect externalizing problems.

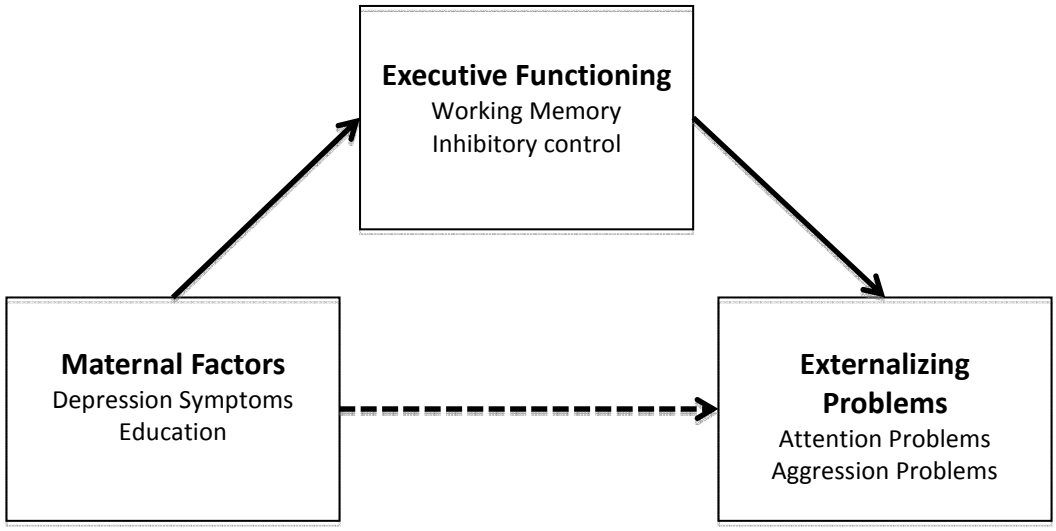

Figure 1-1 Hypothesized Mediation Model

1.6.4 Hypothesis 4

The fourth hypothesis proposed that the inhibitory control of one sibling would significantly predict not only their own externalizing problems, but also their sibling's externalizing problems. I expected increased inhibitory control to be significantly associated with decreased externalizing problems in their brother or sister (Figure 1-2).

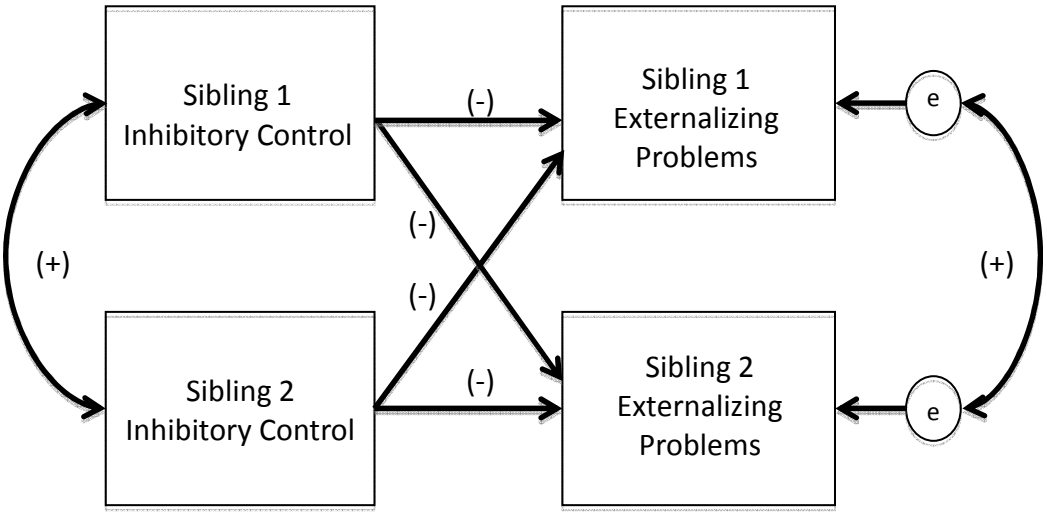

Figure 1-2 Hypothesized Model of the Effects of Siblings on Externalizing Problems

Chapter 2

Methods

2.1 Participants

The current sample included 100 mothers with two typically-developing children between the ages of 2.5 and 5.5. All participants completed online assessments and a lab visit. Of the 100 sibling groups, 57 were full sibling pairs, 10 were monozygotic twin pairs, 21 were same-sex dizygotic twin pairs, 11 were opposite-sex dizygotic twin pairs, and 1 was a group of triplets. The mean age of mothers was 34.13 years (*SD* = 5.13) with an average of 15.58 years of education (*SD* = 2.25), while the mean age of fathers was 36.97 years (*SD* = 6.56) with an average of 15.09 years of education (*SD* = 2.69). Ninety-one percent of respondents reported being married to the biological parent of the children. Families were mostly White, not Hispanic or Latino, with the majority earning an annual income over $70,000 (Table 2-1). The current analyses included 196 children (males = 102) with a mean age of 45.93 months (*SD* = 12.40). The average age of males was 44.75 months (*SD* = 11.74), while the average age of females was 47.22 months (*SD* = 13.02).

Table 2-1 Family Demographics

Variable	(%)	
Annual Income		
< 30,000	5.05%	
30,000-40,000	11.11%	
40,000-50,000	13.13%	
50,000-60,000	10.10%	
60,000-70,000	9.09%	
70,000-80,000	13.13%	
80,000-100,000	15.15%	
100,000-150,000	18.18%	
> 150,000	5.05%	
	Mother (%)	Father (%)
Ethnicity		
Not Hispanic or Latino	93.00%	92.00%
Hispanic or Latino	7.00%	8.00%
Race		
White	88.00%	86.00%
Black or African American	4.00%	7.00%
Asian	1.00%	0.00%
Pacific Islander	0.00%	1.00%
More than One Race	5.00%	4.00%
Other Race	2.00%	2.00%

2.2 Sampling Procedure

Families were recruited beginning in late 2012 throughout the Dallas-Fort Worth Metroplex via flyers on the University of Texas at Arlington campus, pediatricians' offices, and day care centers. Families were also recruited through internet and website postings.

Based on recommendations by Kenny, Kashy, and Cook (2006), I aimed to recruit a minimum of 80 families in order to detect a medium effect of .30 using an alpha of .05 and power of .78. The current study achieved this with 100 families recruited.

Interested participants completed an online screening after which qualified participants were invited to complete a series of online surveys using SurveyMonkey. Of the 126 families who completed the online surveys, 79.37% participated in the lab visit at the University of Texas at Arlington. There were no differences in parental age, parental education, or family income between those who participated in the lab visit and those who did not (Table 2-2). However, those completing only the online surveys had children who were significantly younger (M = 36.64, SD = 13.66) than those who participated in the lab visit, $t(246) = 4.70$, $p < .001$. This is most likely due to the fact that the children of survey-only participants were too young and, thus, ineligible for the lab visit. All procedures were reviewed and approved by the University of Texas at Arlington Institutional Review Board.

Table 2-2 Comparison of Study Participants to Survey-only Participants

	Lab-Visit (n = 100)	Survey-Only (n = 26)			
Variable	Mean (SD)	Mean (SD)	t-value	df	p-value
Mother Age	34.13 (5.13)	33.14 (5.85)	0.85	124	0.395
Father Age	36.01 (6.48)	34.86 (5.73)	0.83	124	0.409
Mother Education	15.58 (2.25)	15.73 (2.05)	-0.31	124	0.758
Father Education	15.09 (2.87)	15.15 (2.22)	-0.11	124	0.911
Family Income	11.27 (3.27)	11.43 (4.23)	-0.20	120	0.840

Note. A score of 11 on Family Income represents an annual income between $60,000 and $70,000

2.3 Measures

2.3.1 Executive Functioning

2.3.1.1 Working memory.

Working memory was assessed with a multi-location search task called Spin the Pots. This task involved a number of visually distinct boxes arranged on a Lazy Susan. The number of boxes used depended on the child's age (8 boxes for 2.5-3.5; 10 boxes for 3.5-4.5; 12 boxes for 4.5-5.5). The child was asked to help the experimenter place stickers in the boxes. The experimenter told the child that there were not enough stickers to fill all of the boxes and two must remain empty. After the stickers were placed in all but two boxes, the experimenter closed the boxes and placed an opaque cloth over the Lazy Susan. Following this, the experimenter turned the Lazy Susan one time around. The experimenter removed the cloth and asked the child to pick a box that had a sticker in it. After making their selection, the experimenter placed the cloth back on the boxes and rotated the Lazy Susan again. This was repeated until all stickers were located or until the maximum number of spins was met (12 spins for 2.5-3.5; 16 spins for 3.5-4.5; 20 spins for 4.5-5.5). Performance scores were calculated by taking the proportion of stickers to spins, making the possible range of scores 0 to 1. Higher scores reflected greater working memory.

2.3.1.2 Inhibitory control.

Stroop task. In this measure of inhibitory control, the child needed to suppress an automatic response in order to give a correct response. Like Spin the Pots, this task was modified for different ages. Children 2.5-3.5 completed the Baby Stroop task. This task involved showing the child a small "baby" cup and a regular-sized "mommy" cup. The experimenter asked the child to point to the baby cup and the mommy cup to ensure they

understood which cup belonged to whom. The experimenter informed the child that they would play an “opposites game”, in which baby would use the mommy cup and mommy would use the baby cup. The experimenter told the child to say “mommy cup” when they saw the baby cup and vice versa. The experimenter showed each cup in a pseudorandom order, bringing one forward at a time for a total of 12 trials. Performance was calculated as the total number of correct trials. Children 3.5 to 4.5 completed the Hand Game. This task involved the experimenter making a fist and pointing a finger while the child imitated the gestures. The experimenter informed the child that they would play an “opposites game”, in which the child must point a finger when the experimenter made a fist, and vice versa. Again, this was repeated for 12 trials and performance was calculated as the total number of correct trials. Children 4.5 to 5.5 completed the Day-Night task. The experimenter showed the child a card with a sun, telling him that this was the “day” card. Next, the experimenter showed the child a card with a moon and stars, telling him that this was the “night” card. Then, the experimenter informed the child that they would play an “opposites game”, in which the child must say the word “night” when they saw the day card and say the word “day” when they saw the night card. Again, this was repeated for 12 trials and performance was calculated as the total number of correct trials. Possible scores ranged from 0 to 12. Higher scores reflected greater inhibitory control.

Delay of gratification. This delay task required the child to resist temptation in the short term in order to receive a larger delayed reward. Unlike the other executive functioning tasks, this task did not increase in difficulty. The children received the same task regardless of age. In this task, the child made a series of choices as to whether they wanted an immediate reward or a larger reward that they could have when they went home. The rewards included goldfish crackers, small toys, and pennies. There were a

total of nine trials (three of each reward type) in a fixed order: one vs. four pennies; one vs. two toys; one vs. six pennies; one vs. four toys; one vs. two goldfish; one vs. six toys; one vs. four goldfish; one vs. two pennies; one vs. six goldfish. Performance was calculated as the total number of trials where the child chose a delayed reward, making the possible range of scores 0 to 9. Higher scores reflected greater inhibitory control.

2.3.2 Verbal Ability

The Peabody Picture Vocabulary Test (4th ed; PPVT-IV; Dunn & Dunn, 2007) was administered to assess the child's level of receptive vocabulary. The experimenter said a word from the standardized list and children pointed to one of four pictures that they thought correctly depicted the word. Testing proceeded until the child answered eight items incorrectly from a block of 12. Performance was based on the standardized score.

2.3.3 Externalizing Problems

The Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2000) was used to assess externalizing problems. The CBCL is the most widely used standardized instrument for measuring child behavior and consists of a list of 99 items regarding the child's behavioral and socio-emotional functioning. The instructions asked parents to rate their child on behaviors concerning their children within the past two months. The scale ranged from 0 (Not True), 1 (Somewhat or Sometimes True), to 2 (Very True or Often True). The completion of the CBCL form required parents to have English reading skills at or above a fifth-grade level (Achenbach & Rescorla, 2000). The two subscales that comprise externalizing problems were used for the current study. First, the attention problems subscale was used to assess attention deficit/hyperactivity problems (e.g. can't sit still, quickly shifts, can't concentrate). Secondly, the aggressive behavior subscale was used to assess oppositional defiant problems (e.g. defiant, hits others, easily frustrated).

Scores were recoded (so that zero was not a possible score) and averaged, making the possible range of scores one to three. Higher scores reflected greater problems. Cronbach's alpha for the five-item attention problems subscale was .75, while Cronbach's alpha for the 19-item aggression problems subscale was .89.

2.3.4 Maternal Depression

The Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977) is a self-report scale intended to assess depression symptoms occurring the week prior (see Appendix A for a list of items). This scale consisted of 20 items with response options ranging from 0 (rarely; less than 1 day), 1 (sometimes; 1-2 days), 2 (occasionally; 3-4 days), to 3 (most of the time; 5-7 days). Items were summed, making the possible range of scores zero to 60. Higher scores indicated the presence of greater symptoms. Scores less than 15 indicated low depression symptoms, scores ranging from 15-21 indicated mild to moderate symptoms of depression, and scores over 21 indicated the possibility of major depression. Cronbach's alpha for the CES-D was .86.

2.3.5 Maternal Education

The education level of the mother was self-reported and measured in years of formal schooling completed (e.g. 12 years for high school diploma, 16 years for bachelor's degree).

2.4 Procedure

Parents were provided electronic consent before completing the online questionnaires via SurveyMonkey. Maternal depression symptoms and maternal education was self-reported using the online questionnaires. Parents received a $25 gift card for completing the online surveys. Next, families came to the lab in the Psychology Department at the University of Texas at Arlington, where they were given further consent forms pertaining to the procedures that day. Siblings were separated into two

rooms, completing tasks separately. Tasks assessing executive functioning (Spin the Pots, Stroop Task, and Delayed Gratification) and verbal ability (PPVT-IV) took place one-on-one with the experimenter. Experimenters included trained graduate and undergraduate students. While the children were completing their tasks, parents completed the CBCL for each child. The laboratory visit took approximately two hours to complete and parents received a $50 gift card upon completion.

Chapter 3

Results

3.1 Data Analysis

Given the nested structure of the study design (e.g. siblings within families), multilevel linear regression was used as the primary means of data analyses to investigate the predictors of attention and aggression problems. When data are clustered, individuals are more like one another than are randomly selected individuals; that is-they are not independent of one another. Ordinary least squares (OLS) regression should be avoided in this case, because the standard errors of OLS regression coefficients are too small, leading to alpha inflation (Cohen, Cohen, West & Aiken, 2003). Multilevel regression models permit the appropriate modeling of the impact of individual level predictors on the dependent variable, yielding proper estimates of standard errors. The application of multilevel modeling to dyadic data required one major restriction, however, and that was to include only fixed effects with respect to the effect of individual predictors on the outcome (Kenny et al., 2006). In general multilevel models, the intercepts and slopes are allowed to vary from group to group, but with dyadic data, the slopes (i.e. the effect of X on Y for each dyad) must be constrained to be equal across all dyads. This is because the clusters do not have enough lower-level units to allow the slopes to vary from dyad to dyad. Importantly, the intercepts for the dyads can vary, and it is through this variation of the intercepts that the non-independence of each individuals' scores was modeled (Kenny et al., 2006).

Hypotheses one and two were tested using a two-level random intercept model using restricted maximum likelihood (REML) estimation in order to investigate the predictors of externalizing problems. Externalizing problems were separated into attention problems and aggression problems, thus, two models were analyzed. Level 1

variables included child gender, child age, working memory, IC-Stroop, IC-delay, verbal ability, the interaction between gender and working memory, the interaction between gender and IC-Stroop, and the interaction between gender and IC-delay. Level 2 variables included maternal depression and maternal education. There were 189 children at level 1 and 94 mothers at level 2. Hierarchical linear modeling (HLM) software (Raudenbush, Bryk, Cheong, Congdon, & duToit, 2011) was used to test hypotheses one and two.

Hypothesis three was tested using multilevel mediation modeling to investigate whether executive functioning mediated the relationship between maternal risk factors and externalizing problems. Multilevel models require each link in the mediational chain to involve a variable affecting another variable measured at the same level or at a lower level, but not a higher level (Krull & MacKinnon, 2001). For this hypothesis, level 2 variables, maternal depression and maternal education were the initial variables affecting the level 1 variables of working memory and inhibitory control. It was hypothesized that these level 1 variables would, in turn, affect the level 1 outcome of externalizing problems. Mediation models were tested for all three executive functioning measures on both outcomes of attention and aggression. HLM software was used to test hypothesis three.

Hypothesis four was tested using an actor-partner interdependence model (APIM; Kenny et al., 2006) to determine whether the inhibitory control of one sibling affected the externalizing problems of the other sibling. This model assumes that when siblings interact, each sibling's outcomes are affected by both his or her own characteristics as well as his or her sibling's characteristics (Kenny et al., 2006). The APIM model also allows for a test of the interaction effect between the siblings' levels of

inhibitory control on the child's externalizing problems. This model was estimated with multilevel analysis using SPSS.

3.2 Data Screening

Prior to formal hypothesis testing, data were screened for implausible and missing values using SPSS Missing Values Analysis. Two cases were removed from the analyses for sensory processing disorder and one was removed for autism. Additionally, two children did not complete any executive functioning tasks or the verbal ability task and were subsequently removed from all analyses. Four variables were missing values: working memory (2.0%), Stroop task (11.2%), delay task (1.5%), and PPVT-IV (1.5%). Using Little's MCAR test, missing values were assumed to be missing completely at random, $\chi^2(75) = 82.02$, $p = .27$. Subsequently, missing values were imputed using the expectation-maximization (EM) algorithm. The imputed data were used for all analyses.

Data were also screened to ensure the data met the assumptions of univariate and multivariate normality. IC-Stroop was negatively skewed and underwent a square transformation in order to approximate a more normal distribution. Both attention problems and maternal depression symptoms were positively skewed and underwent a square-root transformation. After transformations, all variables met the assumption of normality. These transformed variables were used in all subsequent analyses. The data met the assumptions of homoscedasticity, lack of univariate and multivariate outliers, and absence of multicollinearity among predictors. Additionally, the data met the multilevel assumption of homogeneity of level 1 variance for both attention and aggression problems. All predictors used in the multilevel models were grand-mean centered. Typically, predictors are group-centered in multilevel models, however group-centering with dyadic data removes all the variance due to dyad (Kenny et al., 2006). Thus, the zero point for all predictors was the grand mean of those variables.

3.3 Associations Among Variables

A summary of means, standard deviations, and intercorrelations among all variables in the analyses is presented in Table 3-1. Attention problems were significantly related to child age, IC-Stroop, and verbal ability. Unexpectedly, attention problems were not related to working memory or delay of gratification. Attention problems were associated with both maternal depression symptoms and maternal education. Aggression problems were also negatively related to child age and IC-Stroop, but not verbal ability. Like attention problems, aggression problems were not related to working memory nor delay of gratification. Aggression problems were also positively associated with maternal depressive symptoms, but, surprisingly, unrelated to maternal education. As expected, attention and aggression problems were positively correlated.

Notably, none of the executive functioning measures were correlated. Moreover, the only relationship between maternal factors and executive functioning was an association between maternal education and delay of gratification. Finally, maternal depression symptoms and maternal education were negatively correlated.

Table 3-1 Means, Standard Deviations, and Intercorrelations Among Study Variables (N = 196)

		Predictors							Outcomes	
Variable	Mean (*SD*)	Child Age	Working Memory	IC Stroop Task	IC Delay Task	Verbal Ability	Maternal Depression Symptoms	Maternal Education	Attention Problems	Aggression Problems
Child Age	45.93 (12.40)	---	.17*	.39**	.08	.30**	.02	.01	-.16*	-.18*
Working Memory	0.65 (0.19)		---	-.03	-.10	.16*	-.07	.11	-.01	-.12
IC-Stroop Task	86.54 (51.37)			---	-.05	.25**	.04	.003	-.23**	-.18*
IC-Delay Task	4.19 (3.31)				---	-.01	.004	.15*	.04	.13
Verbal Ability	107.72 (14.00)					---	-.21**	.16*	-.22**	-.11
Maternal Depression	2.79 (1.08)						---	-.22**	.17*	.23**
Maternal Education	15.56 (2.26)							---	-.20**	-.12
Attention Problems	1.21 (0.17)								---	.42**
Aggression Problems	1.53 (0.33)									---

Note. IC = Inhibitory Control. Mean age represents age in months. Maternal Depression and attention problems represent square-root transformed values, while IC-Stroop represents square transformed values. *p < .05, **p < .01

Gender differences were found only in executive functioning. Girls showed higher inhibitory control (both Stroop and delay) than boys (Table 3-2). There were no gender differences in working memory, verbal ability, attention problems, or aggression problems.

Table 3-2 Gender Differences Among Study Measures

	Girls (n = 94)	Boys (n = 102)				
Variable	Mean (*SD*)	Mean (*SD*)	*t*-value	df	*p*-value	Effect Size
Working Memory	0.64 (0.19)	0.65 (0.19)	-0.43	194	0.668	-0.05
IC-Stroop Task	96.53 (53.31)	77.33 (47.95)	2.65	194	0.009	0.38
IC-Delay Task	4.78 (3.33)	3.64 (3.21)	2.44	194	0.015	0.35
Verbal Ability	107.67 (13.33)	107.77 (14.66)	-0.05	194	0.960	-0.01
Attention Problems	1.20 (0.17)	1.23 (0.17)	-1.39	194	0.167	-0.20
Aggression Problems	1.52 (0.33)	1.54 (0.32)	-0.32	194	0.750	-0.05

Note. IC-Stroop represents square transformed values. Attention problems represents square-root transformed values.

3.4 Hypotheses 1 and 2

3.4.1 Attention Problems

First, using REML estimation, the null model was tested, in which the only predictor of attention problems was the family effect. The estimates of the variance at Level 1 (.003) and Level 2 (.025) produced an intraclass correlation of .11 (.003/.028). Thus, 11% of the variance in children's attention problems was accounted for at the family level. Results indicated that this family effect was not significant, $\chi^2(93) = 115.94$, $p = .054$. However, Cohen et al. (2003) suggested that any intraclass correlation deviating from zero can produce biased standard errors in ordinary least squares regression. Therefore, multilevel modeling was used to determine the predictors of attention

problems. The null model produced a baseline model fit of -132.32, which was used to assess how greatly more complex models fit the data.

Next, the full model was tested with all child and family level variables used to predict attention problems. The full model took 21 iterations to converge, producing a deviance value of -68.43. This reduction in deviance from the null model was significant, $\chi^2(11) = 63.89$, $p < .001$, indicating a significantly better model fit than the null. A revised model was tested with the non-significant interactions dropped from the model. The revised model took 21 iterations to converge producing a deviance of -90.86. The full model was a significantly better fit than the parsimonious model, $\chi^2(9) = -68.43$, $p = .021$. Thus, the full model was retained.

Results of the tested predictors of attention problems are presented in Table 3-3. As expected, maternal education, IC-Stroop and verbal ability were significantly negatively related to child attention problems. Unexpectedly, maternal depression, child gender, age, working memory, and IC-delay were not predictive of attention problems.

Table 3-3 Predictors of Attention Problems

Fixed Effect	*b*	*SE*	*t*-value	df	*p*-value
Intercept	1.211	0.013	92.12	91	<0.001
Maternal Predictors					
Depression	0.013	0.012	1.12	91	0.264
Education	**-0.011**	**0.005**	**-2.40**	**91**	**0.018**
Child-Level Predictors					
Gender	-0.013	0.016	-0.80	86	0.426
Age	-0.001	0.001	-1.39	86	0.170
Working Memory	0.038	0.056	0.68	86	0.496
IC-Stroop	**-0.001**	**<0.001**	**-2.20**	**86**	**0.030**
IC-Delay	0.005	0.004	1.45	86	0.150
Verbal Ability	**-0.002**	**0.001**	**-2.47**	**86**	**0.016**
Gender X Working Memory	**-0.108**	**0.050**	**-2.18**	**86**	**0.032**
Gender X Stroop	<0.001	<0.001	1.15	86	0.252
Gender X Delay	-0.002	0.003	-0.81	86	0.415

Note. Gender coded as female = 1, male = -1.

As expected, gender interacted with working memory to produce an effect on attention problems. The interaction was further explored to determine how gender moderated working memory. Two additional multilevel regression models were tested for each interaction, one with males coded as 0 and the other with females coded as 0. I did this in order to see the effect of working memory on attention problems for males and females separately. Unexpectedly, as shown in Figure 3, working memory was significantly, positively related to attention problems for boys (b = 0.146, SE = 0.068, $t(86)$ = 2.15, p = .034), while working memory was not significantly related to attention problems for girls (b = -0.070, SE = 0.081, $t(86)$ = -0.86, p = .392).

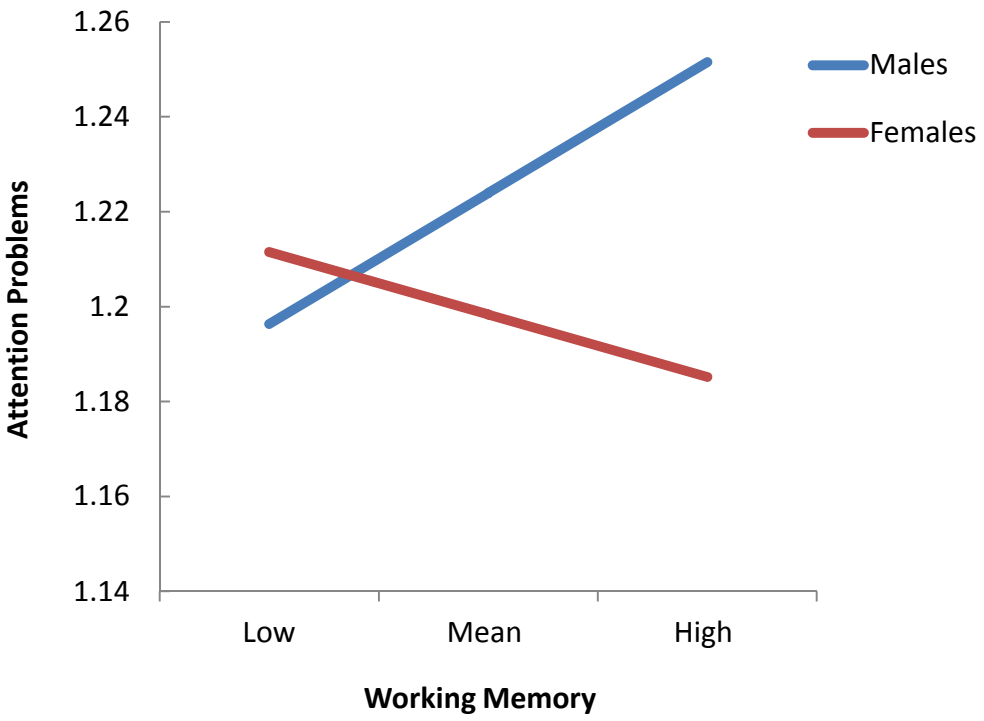

Figure 3-1 Moderation by Gender of the Relationship Between Working Memory and Attention Problems

3.4.2 Aggression Problems

First, using REML estimation, the null model was tested, in which the only predictor of aggression problems was the family effect. The estimates of the variance at Level 1 (.047) and Level 2 (.061) produced an intraclass correlation of .44 (.047/.108). Thus, 44% of the variance in children's attention problems was accounted for at the family level. This effect of family was significant, $\chi^2(93) = 237.86$, $p < .001$, indicating multilevel modeling was both appropriate and necessary. The null model produced a baseline model fit of 98.92.

The full model including all child level and parent level predictors took 11 iterations to converge producing a model fit of 157.39. This fit was significantly worse

than the intercept-only model, $\chi^2(11) = 58.47$, $p < .001$. Thus, a more parsimonious model was tested, dropping the non-significant interactions. This model took 11 iterations to converge and produced a model fit of 136.81, which was significantly better than the full model, $\chi^2(9) = 20.59$, $p = .015$. Both the full and revised models for aggression problems are presented in Tables 3-4 and 3-5.

As expected, greater maternal depression and younger child age predicted increased aggression problems in children. Unexpectedly, maternal education, child gender, working memory, delay, and verbal ability were not predictive of aggression problems. In the revised model, IC-Stroop became significant once the non-significant interactions were removed from the model.

Table 3-4 Full Model of Predictors of Aggression Problems

Fixed Effect	*b*	*SE*	*t*-value	df	*p*-value
Intercept	1.529	0.026	58.69	91	<0.001
Maternal Predictors					
Depression	**0.067**	**0.028**	**2.44**	**91**	**0.017**
Education	-0.012	0.011	-1.07	91	0.289
Child-Level Predictors					
Gender	-0.026	0.037	-0.70	86	0.488
Age	**-0.004**	**0.002**	**-2.51**	**86**	**0.014**
Working Memory	0.012	0.104	0.12	86	0.905
IC-Stroop Task	<-0.001	<0.001	-1.87	86	0.064
Delay	0.010	0.007	1.38	86	0.171
Verbal Ability	<0.001	0.002	0.16	86	0.880
Gender X Working Memory	0.094	0.104	0.91	86	0.368
Gender X Stroop	<0.001	<0.001	1.09	86	0.280
Gender X Delay	0.004	0.007	0.56	86	0.579

Table 3-5 Revised Model of Predictors of Aggression Problems with Interactions Removed

Fixed Effect	*b*	*SE*	*t*-value	df	*p*-value
Intercept	1.535	0.026	58.44	91	<0.001
Maternal Predictors					
Depression	**0.069**	**0.027**	**2.57**	**91**	**0.012**
Education	-0.013	0.011	-1.18	91	0.240
Child-Level Predictors					
Gender	-0.009	0.022	-0.43	89	0.667
Age	**-0.004**	**0.002**	**-2.52**	**89**	**0.014**
Working Memory	-0.016	0.107	-0.15	89	0.880
IC-Stroop Task	**-0.001**	**<0.001**	**-2.13**	**89**	**0.036**
Delay	0.011	0.007	1.51	89	0.135
Verbal Ability	<0.001	0.002	0.21	89	0.834

3.5 Hypothesis 3

Multilevel mediation modeling was used to examine whether the parental effect on externalizing problems was mediated by child executive functioning. First, maternal depression symptoms and maternal education were tested as predictors of working memory, controlling for child age and verbal ability. Depression and education were entered at the same time in order to partial out the effects of each other on each outcome. Contrary to what was expected, neither maternal depression nor maternal education were significant predictors of working memory (Table 3-6). Since neither predictor was related to the proposed mediator, mediation analysis for working memory was discontinued.

Next, maternal depression symptoms and maternal education were tested as predictors of IC-Stroop, controlling for child age and verbal ability. Again, neither predictor was significantly related to IC-Stroop (Table 3-6). Thus, mediation analysis for IC-Stroop was discontinued.

Lastly, maternal depression symptoms and maternal education were tested as predictors of IC-delay. Maternal education was a significant predictor of IC-delay (Table 3-6). However, as seen in the previous analysis, IC-delay was not significantly related to attention or aggression problems. Therefore, although maternal education was related to both IC-delay and attention problems, the effect of maternal education on attention problems was not mediated by IC-delay.

Table 3-6 Effects of Maternal Factors on Executive Functioning

Predictor (*X*)	Outcome (*M*)	*b*	*SE*	*t*-value	*df*	*p*-value
Depression						
	Working Memory	-0.008	0.013	-0.69	91	0.505
	IC - Stroop	3.010	3.435	0.88	91	0.383
	IC - Delay	0.278	0.270	1.03	91	0.307
Education						
	Working Memory	0.007	0.006	1.79	91	0.181
	IC - Stroop	-0.429	1.511	-0.28	91	0.777
	IC - Delay	**0.236**	**0.115**	**2.05**	**91**	**0.043**

3.6 Hypothesis 4

3.6.1 Sibling's Effect on Attention Problems

First, I tested whether the inhibitory control of one sibling affected the other sibling's attention problems. As expected, attention problems were significantly affected by the child's own IC (Stroop; $p = .003$) as well as their sibling's IC (Stroop), $b = < .001$,

SE = < .001, *t*(177.97) = 2.15, *p* = .033. The effect of their sibling's IC, however, was not in the expected direction. Results indicated that as one sibling's IC increased, the attention problems of their sibling increased. Furthermore, one sibling's IC did not interact with the other sibling's IC to produce an effect on attention problems, *b* = < .001, *SE* = < .001, *t*(89) = 1.78, *p* = .079. Contrary to what was expected, neither the child's own delay (*p* = .364) nor their sibling's delay (*b* = .005, *SE* = .004, *t*(178.01) = 1.30, *p* = .195) affected attention problems. Also, the delay of each sibling did not interact to produce an effect on the child's own attention problems, *b* = < .001, *SE* = .001, *t*(89) = 0.21, *p* = .836.

3.6.2 Sibling's Effect on Aggression Problems

First, I tested whether the inhibitory control of one sibling affected the other sibling's aggression problems. Contrary to what was expected, while aggression problems were affected by the child's own IC-Stroop (*p* = .026), aggression was not significantly affected by the other sibling's IC-Stroop, *b* = <.001, *SE* = <.001, *t*(148.13) = 0.82, *p* = .415. Similar to attention problems, neither the child's own delay (*p* = .100) nor their sibling's delay (*b* = .013, *SE* = .007, *t*(173.32) = 1.90, *p* = .059) affected the child's own aggression problems. Moreover, the siblings' IC did not interact to produce an effect on the child's own aggression problems (stroop X stroop: *b* = <.001, *SE* = <.001, *t*(89) = 0.45, *p* = .657; delay X delay: *b* = <.001, *SE* = .003, *t*(89) = 0.06, *p* = .956).

3.7 Post-Hoc Analyses

3.7.1 Interaction between Maternal Depression Symptoms and Maternal Education

As seen in hypothesis 1, maternal education was related to attention problems, but not aggression problems, while maternal depression was related to aggression problems, but not attention problems. Since maternal depression symptoms and education were related, I tested whether these variables interacted to produce an effect on externalizing problems.

The interaction was first tested on attention problems and was entered into the full model. Importantly, the effect of education became non-significant (p = .107) when the interaction term was entered into the model. There was a significant interaction between maternal depression and maternal education on attention problems, b = .011, SE = .004, t(90) = 2.82, p = .006. It appeared that maternal education was moderating the effect of depression on attention problems (Figure 3-2), in that attention problems significantly increased with depression symptoms only at high levels (+1 *SD*) of education, b = .038, SE = .016, t(90) = 2.43, p = .017. The effect of depression on attention problems was not significant at mean levels (b = .012, SE = .012, t(90) = 1.02, p = .312) or low levels (-1 *SD*; b = -.014, SE = .014, t(90) = -0.94, p = .349) of education.

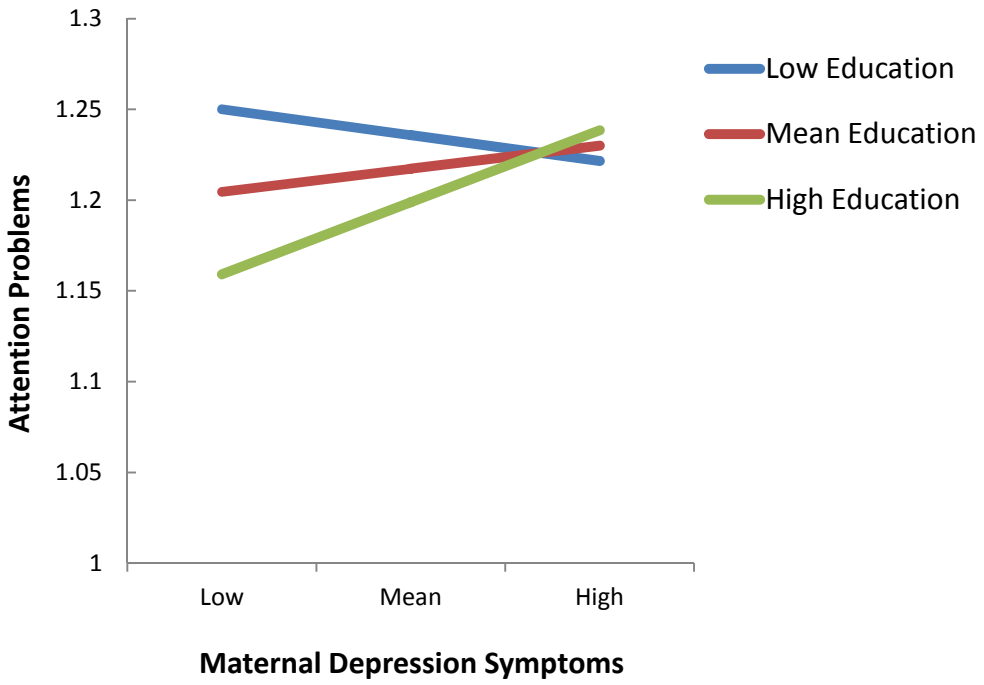

Figure 3-2 Moderation by Maternal Education of the Relationship Between Maternal Depression Symptoms and Attention Problems

Next, I examined whether maternal depression and education interacted to produce an effect on aggression problems. The interaction term was entered into the more parsimonious model (i.e. no level-1 interaction terms). Maternal depression and education did interact to produce an effect on aggression problems, b = .017, SE = .008, $t(90)$ = 2.04, p = .044. Similar to attention problems, it appeared that maternal education moderated the effect of depression (Figure 3-3). Aggression problems significantly increased with greater maternal depression only at high levels (+1 SD) (b = .106, SE = .033, $t(90)$ = 3.20, p = .002) and mean levels (b = .067, SE = .026, $t(90)$ = 2.58, p = .011) of education. The effect of maternal depression on aggression was not significant at low levels of education (-1 SD), b = .028, SE = .031, $t(90)$ = 0.90, p = .368.

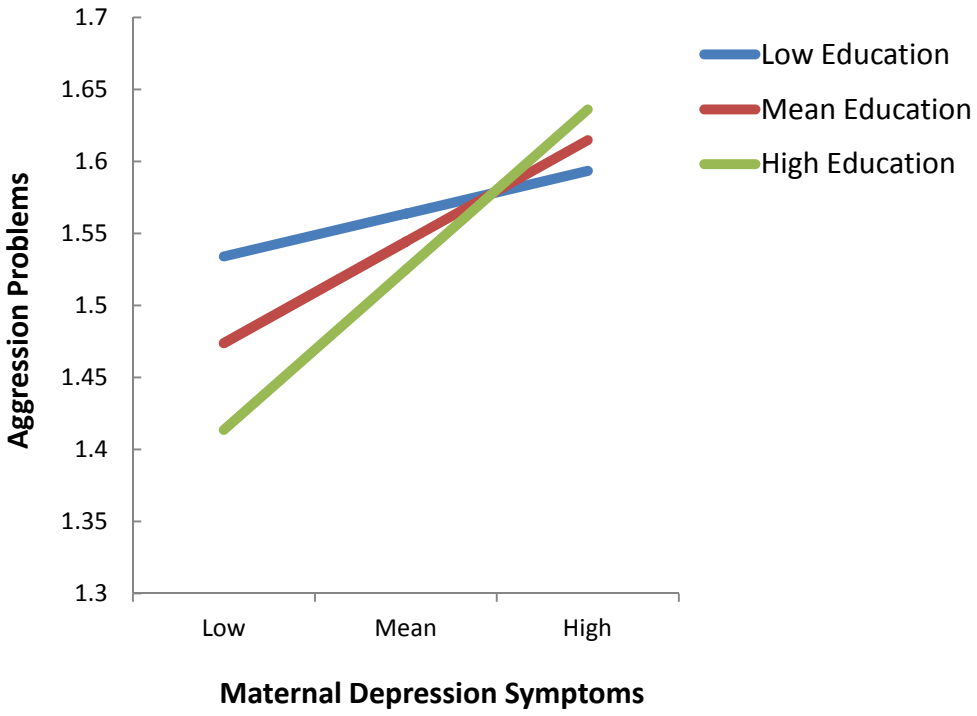

Figure 3-3 Moderation by Maternal Education of the Relationship Between Maternal Depression Symptoms and Aggression Problems

3.7.2 Interaction between Child Age and Child Gender

An interaction between child age and gender was tested for both attention and aggression problems.[1] Age and gender interacted to produce an effect on aggression problems, b = .004, SE = .002, $t(88)$ = 2.05, p = .044. Aggression significantly decreased with age for males (b = -.008, SE = .002, $t(88)$ = -3.37, p = .001) but not females (b = -.001, SE = .002, $t(88)$ = -0.35, p = .727) (Figure 3-4).

[1] Additionally, it was tested whether age and verbal ability interacted with any executive functioning variables. No interactions were significant.

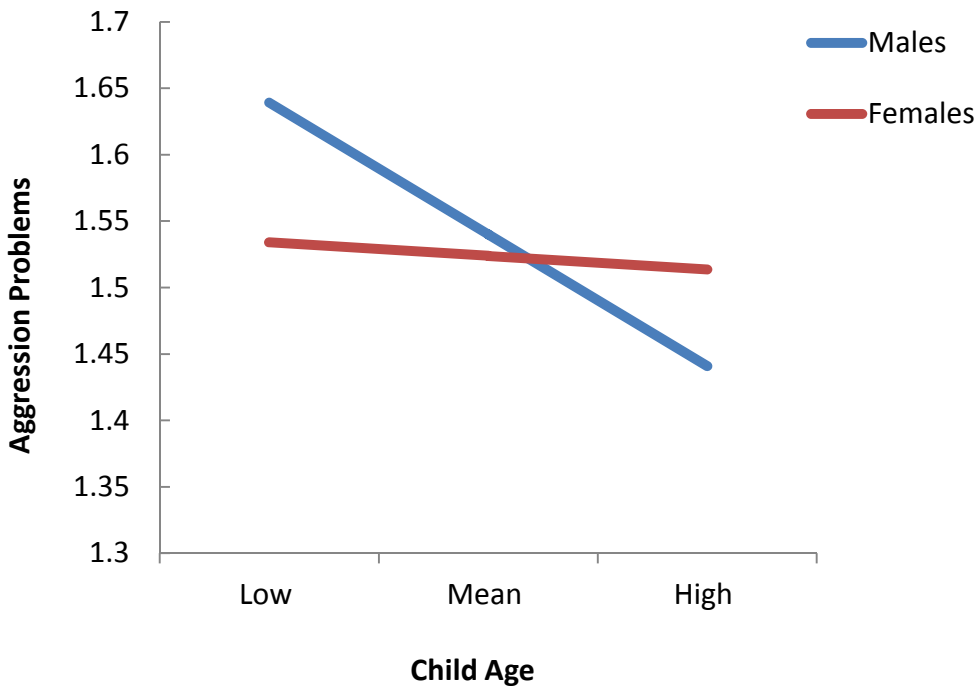

Figure 3-4 Moderation by Gender of the Relationship Between Child Age and Aggression Problems

3.7.3 The Effect of Sibling Gender on Externalizing problems

Although not hypothesized, I tested whether attention and aggression problems were affected by the gender of the child's sibling.[2] In order to test the effects of gender on attention problems, the gender of both the child and their sibling were entered into the model along with the child and sibling's IC-Stroop. Results indicated that attention problems were not affected by the child's gender (p = .124), but they were affected by the gender of the other sibling, b = .035, SE = .012, t(183.89) = 2.91, p = .004. Since males were coded as -1 and females as 1, this indicated that children with female siblings had

[2] All possible effects and two-way interactions between gender, age, IC-Stroop, and IC-delay of each sibling were tested using the APIM model and none were significant. Additionally, a subgroup analysis was performed using a multiple regression model on the effects of older siblings on younger siblings and vice versa (n = 54). No significant effects of the older or younger siblings' externalizing problems were found.

significantly more attention problems. However, neither the child's own gender (p = .674) nor the gender of the other sibling (b = .012, SE = .024, t(169.72) = .49, p = .630) significantly affected the aggression problems of the child.

Chapter 4

Discussion

The primary aim of the current study was to investigate predictors of externalizing problems in young children. Both child-level and family-level predictors were analyzed in the context of a family study design, with a specific focus on child executive functioning and maternal depression and education. Previous research has linked executive functioning to externalizing problems, but little research has been devoted to examining this relationship in very young children (Brocki & Bohlin, 2006; Brocki et al., 2010). The present investigation found executive functioning to be a significant predictor of both attention and aggression problems in young children. Moreover, maternal depression symptoms significantly affected attention and aggression problems, but this effect was moderated by maternal education. Findings are discussed followed by limitations and implications.

4.1 Child-Level Predictors of Externalizing Problems

Among executive functioning measures, inhibitory control (Stroop) predicted both attention and aggression problems, supporting previous findings (Bohlin et al., 2012) of a negative relationship between IC and externalizing problems in young children. Unexpectedly, neither working memory nor delay of gratification predicted attention or aggression problems, which is in contradiction to previous findings by Hughes and Ensor (2008). Results indicated these measures may have not accurately assessed the constructs, which is discussed in detail shortly. Gender moderated the relationship between working memory and attention problems--boys showed a positive relationship between working memory and attention problems, while girls showed no relationship. Contrary to what I hypothesized, boys' attention problems increased relative to an

increase in working memory. It is unclear why this pattern of results emerged, further suggesting an inaccurate assessment of working memory.

Next, child gender did not uniquely predict externalizing problems, supporting the idea that gender differences in externalizing problems are not present in the preschool period (Loeber et al., 2000). However, the effect size for gender differences in attention problems, although small, suggests that a significant difference could possibly be found by including more participants. Although gender did not uniquely predict externalizing problems, post-hoc analyses revealed that gender did play a role in predicting externalizing problems by moderating the effect of age. Aggression problems significantly decreased with age for boys, but not girls. Girls remained constant around the mean of aggression problems at both younger and older ages. At older ages (approximately 4.5 years), boys showed lower aggression problems than girls. Therefore, future research should consider examining trajectories of aggression problems in males and females separately.

Child age was negatively related to aggression problems but not attention problems. Previous research has indicated that externalizing problems show the sharpest decrease from age 2 to 7 (Miner & Clarke-Stewart, 2008). Therefore, the current study provides support for this decrease in a substantially more limited age range. The lack of relationship between child age and attention problems could be due to the small age range, but, importantly, suggests that attention and aggression problems have different trajectories. Previous research has examined trajectories of externalizing problems broadly or aggression problems specifically. The present results indicate a need for investigations of trajectories of attention and aggression problems simultaneously.

Lastly, verbal ability was significantly related to attention problems, not aggression problems, which replicates and expands on previous findings (Hughes &

Ensor, 2008). Verbal ability has previously been linked to externalizing problems broadly, thus the present findings indicate this relationship is being driven by attention problems. Therefore, the development of receptive vocabulary appears to be more important for the regulation of attention than the regulation of aggressive behaviors.

4.2 Family-Level Predictors of Externalizing Problems

Both maternal depression symptoms and maternal education predicted child externalizing problems. Maternal depression symptoms uniquely predicted child aggression problems, but maternal education did not. This is contrary to previous findings suggesting a significant negative relationship between maternal education and aggression (NICHD Early Child Care Research Network, 2004). Previous studies reporting this relationship did not control for maternal depression symptoms, which could possibly explain this inconsistency. Specifically, the correlation between maternal depression symptoms and maternal education indicates these variables may be accounting for overlapping variance in externalizing problems. Thus, the variance in aggression problems that would be accounted for by maternal education is being accounted for by maternal depression symptoms.

Regarding attention problems, maternal education uniquely predicted problems with attention, but maternal depression did not. However, once the interaction between education and depression symptoms was included in the model, the effect of education became non-significant. Importantly, the interaction effect between maternal education and maternal depression symptoms was significant for both attention and aggression problems. It appeared that education was moderating the effect of depression symptoms. Specifically, attention problems increased in relation to maternal depression symptoms only at high levels of education. Similarly, aggression problems increased in relation to maternal depression symptoms only at high and mean levels of education. This finding

suggests that maternal depression symptoms play a prominent role in childhood externalizing problems particularly for mothers with higher levels of education. Depression symptoms did not significantly affect child externalizing problems when mothers had lower levels of education. In this sample, children of mothers with low education tended to have higher externalizing problems regardless of maternal depression symptoms. Future research examining the effects of maternal depression on child outcomes should consider including maternal education as a covariate. It is possible that this interaction effect occurs with other child outcomes such as internalizing problems as well.

Although not investigated in the current study, both maternal depression and education are associated with greater levels of harsh and inconsistent parenting (Turney, 2012; Dumka, 1997), and it is this harshness and inconsistency that may account for negative child outcomes such as externalizing problems. Moreover, children with difficult temperaments and unregulated behaviors may elicit negative and inconsistent parenting that may, in turn, increase externalizing behavior. Thus, there is likely a bidirectional relationship between parenting and child externalizing problems. Future studies should consider examining transactional processes in order to assess the impact of parent-child interactions on child externalizing behavior.

4.3 Mediating Effects of Executive Functioning

Based on prior findings, I anticipated executive functioning to act as a mediator between maternal characteristics and child externalizing problems. In contrast to findings by Hughes & Ensor (2008), maternal depression was not a significant predictor of any executive functioning measure, indicating that executive functioning may not be a mediator between maternal depression symptoms and externalizing problems. However, the present study looked at cross-sectional effects, whereas the previous investigation

examined these relationships using a longitudinal design. Therefore, the negative impact of maternal depression on executive functioning may happen over time. Future studies should consider using a longitudinal design when examining the effect of maternal depression symptoms on child executive functioning.

Although maternal education was positively related to IC (delay), delay was not a predictor of externalizing problems. Moreover, maternal education was not related to either working memory or inhibitory control (Stroop). Thus, executive functioning did not act as a mediator between maternal education and externalizing problems. It would be beneficial to investigate other predictors of both executive functioning and externalizing problems, such as parental conflict, in order to further examine the potential mediating role that executive functioning plays in the development of externalizing problems.

4.4 Sibling Effects on Externalizing Problems

This study presented novel findings on the impact that siblings have on each other. Results indicated that high levels of inhibitory control in one sibling had a negative effect on the attention problems of their sibling. Moreover, children with female siblings showed more attention problems than children with male siblings. A possible explanation for these findings is biased reporting of attention problems by the parent. Parents may be prone to contrast effects, which refers to rater biases that maximize the differences between siblings (Saudino, Wertz, Gagne, & Chawla, 2004). Contrast effects can occur when parents evaluate the behavior of their child based on information about other children they know well. In these cases, the other children they know well are the other children within the family. Consequently, the parents' ratings of one child's attention problems are likely determined based on the other child's attention problems. In the current study, attention problems were lowest for females with high inhibitory control. Thus, children who have siblings who are female and/or have high inhibitory control are

more likely to have higher parent-reported attention problems. Objective measures of attention problems are crucial for determining whether this is truly a result of parent bias or if this is a real effect. Nevertheless, these findings provide further evidence for the idea that siblings play a substantial role in child development. Even if the finding is due to contrast effects, this negative perception of the child could lead to more problems later in life.

Unexpectedly, these effects did not occur for aggression problems, suggesting that siblings' levels of inhibitory control and gender have more of an effect on attention problems rather than aggression. However, different results could emerge by including only full siblings or only twins. Because both full sibling and twin pairs were included, it was difficult to tease out the effects that older siblings had on younger siblings and vice versa. Researchers interested in family study designs should consider this when designing sibling studies.

4.5 Limitations and Implications

Limitations of this study should be taken into account when interpreting the current findings as well as planning future research involving these variables. First, cross-level interactions between child- and family-level data were not tested, because dyadic data do not provide enough degrees of freedom to test cross-level interactions (Kenny et al., 2006). It may be the case that the effect of a child's inhibitory control on externalizing problems is moderated by maternal characteristics or vice versa. Future investigations on this topic should consider including all children within the family, rather than just two. Including bigger groups would increase the degrees of freedom and allow for cross-level analyses.

Secondly, reliable effect size measures in multilevel data are limited. Thus, although inhibitory control and maternal depression symptoms predicted externalizing

problems, it is unclear how large of an effect they had. I conducted an OLS regression analysis to get a sense of the effects. Results indicated inhibitory control was accounting for 2.04% of the variance in attention problems and 1.39% of the variance in aggression problems, while maternal depression symptoms were accounting for approximately 1.44% of the variance in attention problems and 4.45% of the variance in aggression problems. However, due to underestimated standard errors, these numbers may be positively biased. Nevertheless, these numbers represent small effect sizes. However, the negative effects of low executive functioning and maternal depression symptoms on problem behaviors could compound over time. Future research should consider measuring these relationships across child development in order to capture those relationships while the child ages.

Another limitation of the current study is the measure of working memory. Interestingly, there was no relationship between working memory and IC-Stroop, which, if measured accurately, these two variables should be positively correlated. Research by Diamond (2013) found that the relationship between working memory and IC-Stroop is more similar than the relationship between IC-Stroop and other measures of IC. Thus, results indicate that working memory may not have been accurately assessed in this study. The working memory task was modified for different age groups, effectively making it easier for younger children. Consequently, a young child with low working memory relative to an older child could have scored equally well on the task. This ultimately attenuated the relationship between working memory and other measures with which it should have been related. Future investigations of working memory across multiple age groups should not adjust for difficulty of the task if the desire is to look at the effects of working memory on outcomes *across* age.

Similarly, the validity of the delay of gratification task is questionable. Given that the Stroop and delay tasks were both measures of inhibitory control, these measures should have been positively correlated. Moreover, the delay task had a positive relationship with attention and aggression problems, which suggests a faulty task. One possibility for this is a lack of motivating stimuli (pennies, small toys, and goldfish). First, some children may have not understood what pennies represent or were simply uninterested in getting a penny immediately. Consequently, children who possibly had trouble with delaying gratification may have picked the option with multiple pennies just due to a lack of interest. Secondly, although toys seem motivating, each choice involved either one of those toys or multiple of the exact same toy. Children may have been complacent with just the one toy, discounting the need for multiple toys of the same type. Lastly, goldfish crackers are a common snack that parents typically have on hand, which could have made the immediate choice less rewarding. Future research involving delay of gratification should incorporate more motivating stimuli such as sugary snacks. Alternatively, children could pick their favorite things from a variety of stimuli before the task starts to ensure they are motivated to get those rewards.

Next, it has been demonstrated that studies using six executive functioning tasks correlated higher with informant-reported measures of inhibitory control compared to using just three executive functioning tasks (Beck, Carlson, and Rothbart, 2011 as cited in Duckworth et al., 2011). Therefore, using more executive functioning measures would give a more accurate assessment of global functioning. Further, Duckworth et al. (2011) suggested aggregating across executive functioning assessments in order to reduce error variance associated with each individual task. The current study included three separate tasks that were unfortunately uncorrelated. Thus, future research should consider including many executive functioning tasks (> 5) in order to get an accurate

assessment of executive functioning. The effects that were absent in this study could potentially be found in an investigation using more measures of executive functioning.

A final limitation of this study is the fact that the current sample is not representative in terms of the population in terms of race or income, limiting the generalizability of the findings. Further, the majority of mothers in this study were low in depression symptoms. Researchers interested in the effects of maternal depression should aim to recruit a wider range of individuals in order to capture the true effect of maternal depression on externalizing problems.

Regardless of limitations, the current study presents novel findings on the relationships between child- and parent-level characteristics and externalizing problems. This investigation included behavioral assessments of executive functioning and verbal ability in 98 pairs of siblings. Not only were aspects of the child considered, but characteristics of their mother and sibling were included, allowing for a more precise analysis of child externalizing problems. This study demonstrated the important role that siblings play in the development of externalizing problems, providing evidence that females with high inhibitory control have siblings with greater attention problems. Furthermore, this study separated attention and aggression problems, rather than including a broad measure of externalizing problems. The current findings indicate that various aspects of the child and parents may differentially affect attention and aggressive behaviors. Future research should consider separating these externalizing problems to get a more accurate picture of child development.

The present findings highlight the importance of the development of inhibitory control in the preschool years, demonstrating a positive impact on both attention and aggression problems. The current investigation was able to isolate the effect of inhibitory control on externalizing problems, while controlling for child age and verbal ability. In light

of evidence suggesting methods of improving inhibitory control in young children (Diamond & Lee, 2007), further research should analyze the impact of increasing inhibitory control on externalizing problems. Improvements in executive functioning not only contribute to increased attention, but it allows one to develop better control of emotions and their behavioral expression (Fox, 1994). Therefore, increasing executive functioning could have a wider range of positive outcomes not limited to externalizing problems.

Appendix A

Center for Epidemiologic Studies Depression Scale (CES-D), NIMH

Participants were told to check one of four boxes for each item assessing how they felt during the past week. The first box represented “rarely or none of the time (less than 1 day)”; the second box represented “some or a little of the time (1-2 days)”; the third box represented “occasionally or a moderate amount of time (3-4 days)”; the fourth box represented “most or all of the time (5-7 days)”. Zero points were given for rarely, one point for some of the time, two points for occasionally, and three points for most of the time. Questions 4, 8, 12, and 16 were reverse scored. Items were summed (possible range 0-60), with higher scores indicating the presence of more symptomatology.

1. I was bothered by things that usually don’t bother me.
2. I did not feel like eating; my appetite was poor.
3. I felt that I could not shake off the blues, even with the help from my family or friends.
4. I felt I was just as good as other people.
5. I had trouble keeping my mind on what I was doing.
6. I felt depressed.
7. I felt that everything I did was an effort.
8. I felt hopeful about the future.
9. I thought my life had been a failure.
10. I felt fearful.
11. My sleep was restless.
12. I was happy.
13. I talked less than usual.
14. I felt lonely.
15. People were unfriendly.
16. I enjoyed life.
17. I had crying spells.
18. I felt sad.
19. I felt that people disliked me.
20. I could not get “going”.

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Biographical Information

Catherine Spann is in her third year as a graduate student and graduate teaching assistant at The University of Texas at Arlington. She received her Bachelor of Science in Psychology from The University of Georgia in 2010. Prior to research in child development, she has worked as a research assistant examining alcoholism and nicotine dependence, memory impairments in an aging population, and the formation and retrieval of long-term memories using fMRI.

Catherine is currently researching predictors of child self-control during infancy, as well as the negative long-term impacts of low self-control during early childhood. She would like to continue researching predictors and outcomes of self-control, in addition to examining trajectories of self-control across age. Finally, Catherine aims to investigate methods of increasing self-control during early childhood.