TRAJECTORIES OF DSM-IV SYMPTOMS OF ADHD, ODD AND ADHD+ODD IN MIDDLE CHILDHOOD: EXAMINING THE CO-VARIATION OF ADHD AND ODD SYMPTOMS AND THEIR DIFFERENTIAL PREDICTORS AND OUTCOMES

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Although the importance of investigating the developmental course of problem behavior has been emphasized in the developmental psychopathology literature, few studies have examined both ADHD and ODD symptoms longitudinally to ascertain developmental changes in symptom patterns or their co-occurrence across time. Furthermore, few studies control for comorbid symptoms, making it unclear whether ADHD, ODD or their combination drive the reported associations with early risk factors and later negative outcomes. Consequently, the current study aimed to (1) explicate longitudinal patterns of DSM-IV defined ADHD and ODD symptoms and their co-occurrence across middle childhood (ages 9 to 12) using a person-centered, semi-parametric group-based modeling approach (Nagin, 1999); (2) examine the associations of trajectories of ADHD, ODD and ADHD+ODD symptoms with possible early risk factors, children's executive functioning and maternal parenting at 54 months; and (3) investigate whether academic and social outcomes at age 12 varied as a function of symptom trajectories. Prospective data were collected from birth through sixth grade from a community

sample of 1081 children participating in the NICHD Study of Early Child Care and Youth Development (SECCYD). Five longitudinal patterns of ADHD symptoms were identified: very low, low, increasing, decreasing, and high stable symptom trajectories. Only three trajectories of ODD symptoms were identified: very low, low, and high stable symptom groups. The dual symptom trajectory model did not converge making it impossible to explore dual symptom trajectories. Differential associations with early risk factors and later outcomes were found after controlling for comorbid disruptive symptoms. Preschool measures of children's executive functioning predicted later levels of ADHD symptoms, but not ODD symptoms. Maternal sensitivity predicted later ODD and ADHD symptoms and harsh maternal control predicted ADHD symptoms. Later academic performance was associated with ADHD symptoms after controlling for ODD symptoms, but not with ODD symptoms alone. Finally, both ADHD and ODD symptoms were significantly associated with mother- and teacher-reported social skills. These results underscore the importance of early cognitive skills in predicting elevated ADHD symptoms and of early relationship quality in predicting symptoms of both ADHD and ODD; implications for intervention are discussed.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Attention Deficit Hyperactivity Disorder (ADHD) is one of the most common disorders of childhood. Epidemiological studies suggest that approximately 5-10% of all school-aged children meet diagnostic criteria for ADHD (see for review Scahill & Schwab-Stone, 2000). In the DSM-IV (Diagnostic and Statistical Manual of Mental Disorders (4th ed.), American Psychiatric Association, 1994), ADHD is defined by symptoms in two primary areas: hyperactivity-impulsivity and inattention. Childhood ADHD is associated with maladjustment in many domains of functioning over the course of development (American Academy of Pediatrics, 2000), including academic achievement and social relationships. Overall, children with ADHD disproportionately use medical and mental health services compared to children without ADHD (Rowland, Lesesne, & Abramowitz, 2002). The costly toll that ADHD takes on individual adjustment, family life, schools, and social services, underscores the importance of understanding the developmental course of ADHD symptoms and identifying related correlates and outcomes, with the ultimate goal of more accurate identification potentially leading to more effective long-term treatment.

While ADHD is the most extensively studied childhood disorder (Brassett-Harknett & Butler, 2007), important gaps in the literature remain. For instance, even though multiple studies have examined the prevalence and long-term stability of ADHD symptoms, little is known about the trajectories of ADHD symptoms across time. There is a growing consensus that maladaptive

behavior must be examined from a developmental perspective (Sroufe, 1997; Sroufe & Rutter, 1984). Because behavior changes substantially across development, studying problem behaviors at one time point provides only limited information and may even serve to misrepresent the phenomenon of interest (Kraemer, Yesavage, Taylor, & Kupfer, 2000; Lahey et al., 2000). Studying variation in ADHD symptoms longitudinally across middle childhood would provide a picture of the developmental course of symptoms during the elementary school years before their prevalence rate decreases as children transition into adolescence (Costello, Mustillo, Erkanli, Keeler, & Angold, 2003). In addition, investigating the varying patterns of ADHD symptoms across middle childhood would help to clarify whether heterogeneous symptom trajectories exist, and, if so, further examination might reveal differential associations with psychosocial risk factors and outcomes.

As researchers grapple with more complex questions regarding the etiology of ADHD, the dearth of empirical literature examining comorbidity and its potentially confounding effects has become more evident (Angold, Costello, & Erkanli, 1999). ADHD commonly co-occurs with other disorders. For example, Kadesjo and Gillberg (2001) reported a prevalence rate of 87% for one other single comorbid disorder, and a prevalence rate of 67% for two or more comorbid disorders, in a population sample of Swedish children with ADHD. Oppositional Defiant Disorder (ODD) and Conduct Disorder (CD) are the most common conditions comorbid with ADHD (Angold et al., 1999; August, Braswell, & Thuras, 1998; August, Realmuto, Joyce, & Hektner, 1999; Kadesjö & Gillberg, 2001). Much of the existing literature examining the course of ADHD symptoms, as well as their association with psychosocial risk factors and outcomes, has not attempted to parse out how much of the variance is attributable to ADHD symptoms and how much is due to symptoms of co-occurring conditions, such as ODD.

Fortunately, with the advent of more sophisticated statistical techniques and the availability of large-scale prospective studies using longitudinal samples, questions regarding patterns of ADHD symptoms and symptoms of co-occurring conditions over time may now be addressed. Using data collected prospectively from birth through sixth grade from a community sample of children participating in the NICHD Study of Early Child Care and Youth Development (SECCYD), the current study aims to explicate longitudinal patterns of DSM-IV defined ADHD and ODD symptoms and their co-occurrence during middle childhood using a person-centered, semi-parametric group-based modeling approach (Nagin, 1999). Compared to hierarchical linear modeling and growth curve modeling, the other two major statistical approaches that enable researchers to analyze individual level developmental trajectories, Nagin's semi-parametric method provides several advantages. The semi-parametric nature of Nagin's method (i.e., the fact that it does not assume a continuous distribution of trajectories within the population) makes it well suited to analyzing questions about whether children follow distinct developmental trajectories, which are inherently categorical. Furthermore, this trajectory estimation method is equipped to identify, rather than assuming, heterogeneity in types of developmental trajectories (i.e. this methodology can identify subgroups of a population exhibiting patterns of stable, increasing or decreasing symptoms) (Nagin & Tremblay, 1999).

The current study will focus on ADHD symptoms and co-occurring symptoms of ODD, but not CD, for several reasons. First, ODD, along with CD, co-occurs with ADHD at a greater rate than any other childhood disorder (Brassett-Harknett & Butler, 2007; Maughan, Rowe, Messer, Goodman, & Meltzer, 2004). Second, there is some evidence that much of the association between CD/ODD and ADHD, is in fact due to ODD rather than CD (Costello et al., 2003). Third, as CD symptoms manifest in more extreme behaviors than ODD symptoms and

often emerge in adolescence, a community sample studied until age 12 is not likely to provide a wide enough range of CD behaviors to be meaningful, whereas ODD symptoms are likely to be more evident given both the normative sample and age range studied. Finally, the current study will also examine the associations of trajectories of ADHD, ODD and ADHD+ODD symptoms with earlier child and family risk factors and with adjustment outcomes at age 12. By investigating putative risk factors and negative outcomes as a function of symptom trajectories, while also controlling for the effects of comorbid symptoms, this study aims to provide some clarification regarding the differential relations between symptom patterns and child and family factors. Although sex differences may be relevant to the trajectories of symptoms of disruptive behavior as well as their predictors and outcomes, a thorough examination of sex effects is beyond the scope of this paper.

1.1 THE DEVELOPMENTAL COURSE OF ADHD SYMPTOMS ACROSS CHILDHOOD

Despite the fact that Attention-Deficit/Hyperactivity Disorder (ADHD) is one of the most commonly diagnosed and studied childhood disorders (see for review: American Academy of Pediatrics, 2000; Tannock, 1998), major questions remain regarding its developmental course, co-occurrence with other behavior problems, and the nature of its early markers and later negative outcomes (Brassett-Harknett & Butler, 2007; Willoughby, 2003). As reviewed by Willoughby (2003), two general strategies have been employed to study the developmental course of ADHD. *Diagnostic retention studies* exemplify the first strategy. These studies identify children who meet diagnostic criteria for ADHD at one point in time and then determine

what proportion of these children continue to meet diagnostic criteria at subsequent assessments. A second strategy is illustrated by *symptom trajectory studies*, in which the number of ADHD symptoms exhibited by individuals across time is examined (Willoughby, 2003).

A recent series of diagnostic retention studies examining the diagnostic stability of ADHD in clinic-referred samples (Barkley, Fischer, Edelbrock, & Smallish, 1990; Biederman, Faraone, Milberger, Curtis, & et al., 1996) and community samples (August et al., 1998; Taylor, Chadwick, Heptinstall, & Danckaerts, 1996) have reported rates of diagnostic persistence ranging from 69% to 85%. These results attest to the chronic course of the disorder, but do not elucidate the variation in symptom levels over time. In contrast, symptom trajectory studies examine longitudinal patterns of ADHD symptoms, thereby supplying a more nuanced view of their developmental course. For example, based on their symptom trajectory study, Hart and colleagues (1995) found that hyperactive-impulsive symptoms significantly declined from 8 to 15 years of age, whereas inattentive symptoms did not. In contrast, Biederman, Mick, and Faraone (2000) reported that symptoms of hyperactivity, impulsivity, and inattention all decreased with increasing age. Even though these studies provide us with valuable information regarding the developmental course of ADHD symptoms, they do not examine the heterogeneous symptom pathways exhibited by individuals over time. Understanding the heterogeneity in the developmental course of ADHD behaviors would help to differentiate and, thereby, potentially provide information about prognosis. Furthermore, examining the characteristics, predictors, and outcomes that differentiate among heterogeneous symptom pathways may provide insight into the underlying mechanisms of ADHD (Willoughby, 2003).

1.2 THE DEVELOPMENTAL COURSE OF ODD SYMPTOMS ACROSS CHILDHOOD

The diagnosis of oppositional defiant disorder, or oppositional disorder as it was first called, was introduced in 1980 in DSM-III (American Psychiatric Association, 1980). Currently, according to DSM-IV, ODD refers to a recurrent pattern of developmentally inappropriate levels of negativistic, defiant, disobedient, and hostile behavior toward authority figures (American Psychiatric Association, 1994). Along with ADHD and CD, ODD is one of the most prevalent childhood disorders and is one of the leading reasons for referral to youth mental health services (Loeber, Burke, Lahey, Winters, & Zera, 2000). Clinical levels of ODD symptoms commonly co-occur with other psychiatric disorders, including ADHD, CD, and anxiety and depressive disorders (Angold et al., 1999; Burke, Loeber, Lahey, & Rathouz, 2005; Loeber, Burke, et al., 2000). Furthermore, children who exhibit elevated levels of ODD symptoms are reported to experience higher rates of family adversity (Cunningham & Boyle, 2002), ineffective parenting or disrupted parent-child relationships (Burke, Loeber, & Birmaher, 2002; Cunningham & Boyle, 2002), and social deficits (Frankel & Feinberg, 2002; Matthys, Cuperus, & Engeland, 1999) compared to their "normal" peers.

Despite the relatively high prevalence rate of ODD during childhood and its associated negative outcomes, the extant literature examining the developmental course and associated correlates of ODD symptoms is scant (Nock, Kazdin, Hiripi, & Kessler, 2007). Several factors may account for the dearth of literature focusing primarily on symptoms of ODD, such as the common association in the research literature of ODD symptoms with CD, and the changes in the diagnostic criteria defining ODD. From its inception in DSM-III to its current manifestation in DSM-IV, ODD has gone through several diagnostic permutations characterized by a

progressive tightening of the criteria (Angold & Costello, 1996; Lahey et al., 1994). While these changes have served to further differentiate symptoms of ODD from "normal" or developmentally appropriate behavior (Rowe, Maughan, Costello, & Angold, 2005), they have also made it difficult for a large body of consistent and generalizable research findings to accrue. Consequently, although several studies have examined oppositional symptoms across time (Bongers, Koot, van der Ende, & Verhulst, 2003; Costello et al., 2003; Lavigne et al., 1998; Lavigne et al., 2001; Nagin & Tremblay, 1999; Rowe, Maughan, Pickles, Costello, & Angold, 2002; Speltz, McClellan, DeKlyen, & Jones, 1999; van Lier, van der Ende, Koot, & Verhulst, 2007), only a few of them have used DSM-IV symptom criteria (Bongers, Koot, van der Ende, & Verhulst, 2004; Costello et al., 2003; Rowe et al., 2002; van Lier et al., 2007).

Costello and colleagues (2003) assessed the prevalence and development of psychiatric disorders longitudinally from age 9 through 16 years in a community sample. Homotypic continuity was reportedly significant for ODD, indicating that a diagnosis of ODD at one time point significantly predicted to a diagnosis of ODD at a future time point. Using the same rural, community-based sample as Costello et al., Rowe and colleagues (2002) found that an ODD diagnosis was relatively stable among both boys and girls. While each of these studies provides valuable information regarding the prevalence and continuity of DSM-IV ODD symptoms, neither of them examine how symptoms of ODD cluster and vary across multiple time points.

In contrast, van Lier and colleagues (2007) and Bongers et al. (2004) examined the longitudinal trajectories of ODD symptoms, as measured by a child behavior rating scale (CBCL 4/18: Achenbach, 1991), in a community sample of Dutch boys and girls followed from 4 to 18 years of age. Van Lier et al. investigated the development of ODD symptoms and their co-occurrence with symptoms of the other disruptive behavior disorders over time. Using summed

scores from five CBCL items (maximum score = 10) with content similar to DSM-IV criteria, van Lier et al. found four trajectories of ODD symptoms from 4 to 18 years of age. Overall, 6% of their community sample followed a trajectory characterized by high (averaging a score of 6 out of 10) ODD symptoms. The largest proportion of the sample (46%) followed a low ODD trajectory (rated as a 1 or a 2 out of 10), while approximately 28% fell into a moderate ODD trajectory, and the remaining 21% had near zero levels of ODD problems.

Bongers and colleagues (2004) examined group-based developmental trajectories of aggression, opposition, property violations, and status violations in the same sample. These four clusters of externalizing behaviors were based on a scheme developed by Frick et al. (1993). Seven items, which roughly correspond to some of the symptom criteria outlined in DSM-IV, constituted the opposition scale. The authors found six developmental trajectories for oppositional behavior from age 4 to age 18. Two groups, constituting 31% of their sample, exhibited near zero levels of oppositional behaviors. Six percent of the sample were found to follow an 'adolescent increasers' pathway: they showed very little opposition during childhood but increasing levels during adolescence. Two other groups, the 'medium decreasers' (33%) and the 'high decreasers' (24%) showed decreasing trajectories of oppositional behaviors from childhood to adolescence. Finally, 7% of the sample exhibited high persistent levels of oppositional behavior.

Although these two studies (Bongers et al., 2004; van Lier et al., 2007) are among the first to track trajectories of oppositional behaviors, they possess certain limitations. The authors themselves identified the absence of DSM-IV diagnostic criteria, the sole use of parent-report measures of child behaviors, and the fact that the trajectories described cover an age range from 4 to 18 years, whereas the time period covered by any participant was only 8 years, as

limitations. Recently, Drabick, Gadow and Loney (2007) compared four strategies for classifying children based on teacher and/or mother report and concluded that the optimal strategy involved using both mother and teacher report. Although the use of behavior rating scales provides useful information, the results may not be generalizable to children meeting DSM-IV diagnostic criteria or exhibiting DSM-IV defined symptoms. Finally, the divergent number of trajectories of oppositional behaviors obtained in each study is most likely due to the different ways they measured oppositional behavior, highlighting the effect that different measurement strategies can have on the results.

Without empirical studies investigating how symptoms of ODD, as defined by the current DSM-IV criteria, vary across time, our understanding of the disorder as it is currently defined is hindered. Examining trajectories of ODD symptoms across middle childhood would elucidate the developmental course of ODD and further our understanding of the continuity and discontinuity of ODD symptoms over time. In addition, the specificity of associations between ODD symptoms and predictors and outcomes, after controlling for co-occurring symptoms of ADHD, could be clarified. To date, no study has examined the course of ODD symptoms across middle childhood, using multiple informants and DSM-IV symptom criteria, while also taking into account symptoms of ADHD.

1.3 THE CO-OCCURRENCE OF ADHD AND ODD SYMPTOMS ACROSS CHILDHOOD

Although many studies have documented the frequent co-occurrence between ADHD and ODD (Angold et al., 1999), the study of comorbidity has also emerged as an important task itself.

Several review articles (Achenbach, 1995; Caron & Rutter, 1991; Kendall & Clarkin, 1992; Rutter, 1997) have outlined the importance of investigating comorbidity in order to understand the etiology and course of specific disorders. Rather than rehashing their arguments, this section of the literature review will focus on highlighting what we know and do not know about the co-occurrence and co-variation of ADHD and ODD symptoms.

Studies using clinic-referred or high risk and community-based samples (Biederman, Faraone, Milberger, Jetton, & et al., 1996; Costello et al., 2003; Gadow, Sprafkin, & Nolan, 2001; Lavigne et al., 2001; Nock et al., 2007; D. S. Shaw, Lacourse, & Nagin, 2005; Speltz, McClellan, et al., 1999) have reported both on the simultaneous occurrence of elevated levels of ADHD and ODD symptoms, which shall be referred to as *concurrent comorbidity*, as well as prevalence rates of ADHD and ODD symptoms co-occurring in the same individual but not at the same time, i.e. *sequential comorbidity.* In general, empirical research has provided strong evidence of significant concurrent and sequential comorbidity between ADHD and ODD symptoms in both community and clinical samples of boys and girls between 2 and 17 years of age (Angold et al., 1999; Biederman, Newcorn, & Sprich, 1991; Pliszka, 2000). A few studies have gone so far as to study which disorder precedes the other one in development (Costello et al., 2003; Nock et al., 2007). Clinically elevated levels of ADHD symptoms were found to precede (Nock et al., 2007) or significantly predict later ODD symptoms, even after controlling for concurrent comorbidity (Costello et al., 2003).

To date, Shaw and colleagues (2005) have conducted the only study that we know of that examines trajectories of both hyperactive/attention (HAP) and conduct problems (CP). Using Nagin's (1999) semi-parametric person-centered modeling method, they examined the separate trajectories of HAP and CP in their sample of 2- to 12-year old high-risk boys. After

ascertaining that four subgroups of symptom patterns characterized the longitudinal course of both HAP and CP symptoms, the researchers went on to examine the co-occurrence of these symptom patterns over time. Subgroups displaying heterogeneous patterns of HAP or CP symptoms were found. More specifically, a small group of boys demonstrating persistently low levels of symptoms of both HAP (5.7%) and CP (10.1%) symptoms was found. A group of 'moderate desisters,' characterized by high symptom scores at age 2 that declined significantly by age 10, was identified for both HAP (26.9%) and CP (33.2%) trajectories. The majority (47.2%) of boys exhibited a 'moderate stable' pattern of HAP symptoms from toddlerhood to school-age. In contrast, the majority (49.9%) of boys evinced a 'moderate declining' pattern of CP symptoms over time. Finally, both HAP and CP trajectories also included a persistently high or 'chronic' group; the size of this group varied as a function of symptom type (HAP: 20%; CP: 6%).

In order to examine the rate of comorbidity of persistent CP and HAP trajectories, Shaw and colleagues (2005) conducted dual-trajectory analyses which calculated the joint probabilities of following a specific CP and HAP trajectory. The authors reported that the vast majority of boys (93%) in the persistently low HAP group also followed the two lowest CP trajectories, whereas fewer (72%) boys in the persistently low CP subgroup also exhibited symptoms of HAP consistent with the two lowest trajectories of HAP. Over half of boys (55%) who followed a chronic high CP trajectory were also grouped in the chronic high HAP symptom subgroup. In contrast, only 19% of the boys demonstrating chronic high levels of HAP symptoms over time were also found to display persistently high levels of CP symptoms. Finally, the authors also investigated whether child, family and sociodemographic risk factors differentiated boys in the chronically high HAP-only and CP trajectories, in the low HAP and CP trajectory groups, and

the remaining symptom subgroups combined. No differences were found between the two chronic high groups of HAP-only and CP symptoms. However, boys exhibiting lower levels of HAP and CP symptoms were found to have lower levels of child and family risk factors than those boys demonstrating persistent high trajectories of HAP-only and CP symptoms.

Shaw and colleagues' (2005) study represents a great stride forward in understanding how symptoms of ADHD and CP co-occur over time. However, because the primary focus of their study was on the comparison of CP and HAP, the investigators did not compare the separate HAP and CP trajectories on measures of functioning, thereby losing the opportunity to explore how HAP and CP symptom levels, controlling for comorbidity, differentially relate to risk factors. Furthermore, out of necessity, certain limitations were present in the study. The restriction of their sample to low-income, urban boys constrains the generalizability of their results. In addition, the CP and HAP symptoms were measured using items from a behavior questionnaire, which again raises questions about the generalizability of their results to DSM-IV disorders. Finally, in line with the stated aims of the study, the five items measuring CP included three behaviors similar to DSM-IV symptoms of CD, and only two behaviors representative of symptoms of DSM-IV ODD. Even though it is common practice in the literature to create CP constructs that contain features of both ODD and CD, the use of these items makes it difficult to map these findings onto the symptoms of DSM-IV ODD.

The current study will add to the findings discussed above by examining the co-occurrence of DSM-IV ADHD and ODD symptoms across middle childhood in a community sample of boys and girls from 3rd to 6th grades. Investigating this phenomenon would provide several benefits. First, both normative and deviant patterns of co-occurring DSM-IV defined ADHD and ODD symptoms would be elucidated. Second, examining the longitudinal course of

symptoms may help to shed light on questions of equifinality and multifinality. More specifically, the nature of the trajectories may illustrate instances of multifinality and / or equifinality, such as subgroups demonstrating similar levels of symptoms at 3rd grade but different levels of symptoms at a later time point or vice versa. Finally, illuminating groups of children exhibiting various patterns of co-occurring ADHD and ODD symptoms across middle childhood and their relation to risk factors and negative outcomes may provide further evidence that ADHD and ODD are meaningful separate nosological entities. Nosological validity can, in part, be established by demonstrating that a particular disorder differs from other disorders on variables external to the diagnostic criteria (Szatmari, Boyle, & Offord, 1989).

1.4 PREDICTORS OF ADHD AND ODD SYMPTOMS

1.4.1 Parenting factors

As parents represent one of the earliest, most constant and proximal influences on child development, common sense suggests that parenting behavior may serve as an important environmental factor for developmental outcomes in children. Indeed, several prominent models including Patterson's (1982) coercive family process and Baumrind's (1966, 1967) description of parenting styles outline potential mechanisms through which parenting may negatively or positively influence children's behavior. According to Patterson, negative parenting and children's difficult behavior can interact and reinforce each other. Over time this coercive cycle strengthens and escalates the maladaptive behavior exhibited by both the mother and the child. Alternatively, Baumrind and Black (1967) found that parenting characterized by sensitivity,

responsiveness, and non-coercive control is associated with positive academic and behavioral outcomes in children. The authors labeled the latter parenting style "authoritative" and contrasted its effects with "authoritarian" parenting, which is defined by low warmth, excessive demands and need for control. They found "authoritarian" parenting to be related to poorer outcomes for most children. The relation between parenting and child behavior is best viewed as an interaction: parenting behavior and child behavior influence each other in a bidirectional manner. However, behavior genetic studies suggest that maternal negativity and maternal warmth continue to predict child behavior problems even after genetic influences are controlled, providing support for the specific effects of parenting behavior (Caspi et al., 2004).

Despite the large body of research that this area has generated, the current literature is still riddled with inconsistent findings, particularly in relation to the association between parenting style and symptoms of ADHD. Even though many studies have found a significant association between ADHD behaviors and parenting factors, this association is by no means ubiquitous in families with ADHD (Cunningham & Boyle, 2002; Schachar & Tannock, 1995). In light of the high comorbidity between ADHD and ODD symptoms, the contradictory findings regarding the association between ADHD symptoms and parenting practices may be partly accounted for by the failure to consider co-occurring symptoms of ODD, which have well-documented associations with negative and unresponsive parenting.

Indeed, researchers have recently begun to examine the relation of parenting practices to ADHD and ODD symptoms in an effort to parse out differential associations (Chronis et al., 2007; Cunningham & Boyle, 2002; Johnston, 1996; Loeber, Green, Lahey, Frick, & McBurnett, 2000; Pfiffner, McBurnett, Rathouz, & Judice, 2005; Seipp & Johnston, 2005; D. S. Shaw, Owens, Giovannelli, & Winslow, 2001; Stormshak, Bierman, McMahon, & Lengua, 2000). The

results that have emerged indicate that parenting problems may indeed be specific to children who exhibit symptoms of ODD only and to the subgroup of children with ADHD who also have ODD (Pfiffner et al., 2005). More specifically, these studies suggest that certain kinds of dysfunctional parenting, including lack of maternal responsiveness (Seipp & Johnston, 2005), lack of warmth and positive involvement (D. S. Shaw et al., 2001), and negative discipline (Stormshak et al., 2000) are related to comorbid oppositional or conduct problems rather than ADHD alone. In addition, negative parenting has been found to predict the persistence of ODD symptoms, but not ADHD symptoms (August et al., 1999), and positive parenting has been found to protect against the development of conduct problems several years later among young children diagnosed with ADHD (Chronis et al., 2007).

In summary, studies examining maternal parenting practices, specifically constructs similar to harsh control and lack of sensitivity, in relation to comorbid symptoms of ADHD and ODD have generally concluded that negative parenting practices are associated with ODD symptoms, and comorbid ADHD and ODD symptoms. In contrast, some studies find that parents of children who exhibit ADHD symptoms only demonstrate more negative and less sensitive parenting practices than do parents of non-problem children (Johnston, 1996; Lindahl, 1998). Therefore, based on the findings to date, it appears that parenting behaviors are most problematic in families of comorbid children, least problematic in families of non-problem children, and variable in families of children with ADHD symptoms only. The current study attempts to disentangle these relations further by examining whether two commonly studied parenting factors, maternal use of harsh discipline (conceptually similar to Baumrind's (1971) "authoritarian" parenting style) and maternal sensitivity (characteristic of Baumrind's

"authoritative" parenting style), predict heterogeneous trajectories of DSM-IV ADHD, ODD, and / or ADHD+ODD symptoms across middle childhood.

1.4.2 Child factors: Executive function

Over the past fifteen years, several theoretical models of ADHD have emerged, including the Delay Aversion Hypothesis (Sonuga-Barke, 1994), the Executive Function Model (Pennington & Ozonoff, 1996), and the Behavioral Inhibition Model (Barkley, 1997). According to the Delay Aversion Hypothesis, ADHD symptoms are accounted for by an underlying motivational style (Sonuga-Barke, 1994, 2002; Sonuga-Barke, Houlberg, & Hall, 1994), reflected in a primary deficit in their reward processes (a shorter than normal delay-of-reinforcement gradient), which translates into decreased tolerance for delay (Sagvolden & Sergeant, 1998). As a result, children with ADHD are motivated to escape or avoid delay. In contrast, Pennington and Ozonoff (1996) proposed that an underlying combination of executive function and general cognitive deficits account for the symptoms of ADHD. They define executive function as "the ability to maintain an appropriate problem-solving set for attainment of a future goal," which includes such domains as inhibition, working memory, planning, and interference control. Their Executive Function Model rests upon the results of 18 studies, which demonstrate that deficits on executive function tasks are consistently found in samples of ADHD children (Pennington & Ozonoff, 1996; Sergeant, Geurts, Huijbregts, Scheres, & Oosterlaan, 2003). Finally, Barkley's (1997) Behavioral Inhibition Model also identifies executive function deficits as primary. According to Barkley, a primary deficit in behavior inhibition interferes with the development of other components of executive functioning, such as attention, planning, and working memory.

Empirical support has been reported for all three models, prompting Nigg and others (Nigg, Willcutt, Doyle, & Sonuga-Barke, 2005; Sonuga-Barke, 2005) to argue for causal heterogeneity and different developmental pathways in the etiology of ADHD. Although the majority of studies assessing various aspects of executive functioning, such as inhibition and planning, as well as delay tolerance, have demonstrated that school-age children exhibiting ADHD symptoms show deficits on these tasks compared to children without signs of ADHD (Barkley, Grodzinsky, & DuPaul, 1992; Corkum & Siegel, 1993; Losier, McGrath, & Klein, 1996; Oosterlaan, Logan, & Sergeant, 1998; Pennington & Ozonoff, 1996; Tannock, 1998; von Stauffenberg & Campbell, 2007), important questions remain regarding whether these deficits in executive function and delay are unique and specific markers of ADHD. For instance, most studies that have examined the relation between executive function deficits, delay and symptoms of ADHD have not controlled for comorbid symptoms of ODD, despite their high rates of comorbidity. In addition, a small body of literature examining executive function deficits in children exhibiting ODD symptoms has found them to evidence significant deficits (see for review: Oosterlaan et al., 1998). Unfortunately, both bodies of research have generally failed to control for the potential effects of comorbid disruptive behaviors. Therefore, the findings showing significant associations between ADHD, or ODD, and executive function and/or delay deficits may merely be an artifact of the presence of comorbid disruptive symptoms.

In an attempt to clarify whether deficits in executive function and delay are specific to either symptoms of ADHD or ODD, researchers have begun to control for the presence of comorbid symptoms (Berlin & Bohlin, 2002; Brocki, Nyberg, Thorell, & Bohlin, 2007; Nigg, Hinshaw, Carte, & Treuting, 1998; Oosterlaan, Scheres, & Sergeant, 2005; Speltz, DeKlyen, Calderon, Greenberg, & Fisher, 1999; Thorell & Wahlstedt, 2006). Two of these studies

examined the differential relation of inhibition deficits with symptoms of ADHD and ODD in community samples of young children (Berlin & Bohlin, 2002; Thorell & Wahlstedt, 2006). They found that inhibition deficits were related to symptoms of both ADHD and ODD. However, once comorbid symptoms of ADHD were controlled, the relation no longer held for symptoms of ODD. In contrast, the association between ADHD symptoms and inhibition deficits remained significant even after controlling for ODD symptoms. A similar pattern of results was found in the other four studies (Brocki et al., 2007; Nigg et al., 1998; Oosterlaan et al., 2005; Speltz, DeKlyen, et al., 1999) using clinic-referred samples and measures of executive functioning assessing inhibition and planning.

In summary, relatively little research has attempted to differentiate between the predictive relations of executive function deficits and symptoms of ADHD and ODD, and none that we know of assess the relation between early ability to delay responding and trajectories of ADHD and ODD symptoms. Those studies that have been conducted appear to support the specificity of inhibition and planning to symptoms of ADHD. However, to date no studies have been identified that examine the differential relation between trajectories of ADHD, ODD, and ADHD+ODD symptoms in middle-school with inhibition, planning and delay measured in preschool and first grade. The present study aims to shed further light on the differential relations of early executive function and delay deficits as predictors of symptoms of ADHD, ODD, and ADHD+ODD symptoms assessed longitudinally during middle-school.

1.5 SOCIAL AND ACADEMIC OUTCOMES ASSOCIATED WITH ADHD AND ODD SYMPTOMS

1.5.1 Social competence

The extent of interpersonal difficulties experienced by many children with ADHD has been well documented (Frederick & Olmi, 1994; Nixon, 2001; Pelham & Bender, 1982). According to some research, as many as 50% of all children with ADHD have significant problems with their peer relationships and experience a high rate of peer rejection (Guevremont & Dumas, 1994; Milich & Landau, 1982). Moreover, Gresham and colleagues (1998) found that 70% of elementary school children with comorbid ADHD and conduct problems had no reciprocated friends in their classrooms. This high rate of social difficulties may be explained by the inappropriate behavior exhibited by children with ADHD. For example, off-task, noisy, disruptive, and rule-violating behaviors are found at higher rates in children with ADHD than their normal peers (Landau & Moore, 1991) and are also associated with peer rejection (Guevremont & Dumas, 1994). Other researchers have focused on the pivotal role that aggressive behavior plays in the peer rejection in children with ADHD (Erhardt & Hinshaw, 1994).

Obviously, aggressive, disruptive, and rule-violating behaviors are not unique to children exhibiting symptoms of ADHD. Rather, these behaviors are also characteristic of children with symptoms of ODD when compared to their non-affected peers (Greene et al., 2002). Unfortunately, however, the majority of studies examining social competence amongst children with symptoms of ADHD have generally failed to control for comorbid disruptive disorder

behaviors. Therefore, links between social competence and ADHD symptoms reported in prior studies may, in fact, be due, in part, to the presence of ODD symptoms.

Researchers have begun to examine the differential relation between symptoms of the disruptive disorders and children's social competence (Drabick et al., 2007; Frankel & Feinberg, 2002; Kuhne, Schachar, & Tannock, 1997; Matthys et al., 1999). In a recent meta-analysis examining comorbid hyperactive-impulsive-attention (HIA) problems and conduct problems (CP) (Waschbusch, 2002), peer difficulties were generally significantly worse in the comorbid group compared to the HIA-only, CP-only, and no-problem groups. However, this association between more impaired social functioning and co-morbidity was evident only among clinic samples. Furthermore, children who exhibited HIA-only behaviors were rated as having more peer difficulties than children with CP-only across all of the studies examined, suggesting that social difficulties are more specifically associated with symptoms of ADHD.

The more recent studies which have included various disordered comparison groups report more nuanced results regarding the relation between social deficits and symptoms of ADHD and ODD (Frankel & Feinberg, 2002; Matthys et al., 1999). Frankel and Feinberg (2002) examined four groups of children in a sample referred for friendship problems. One group was diagnosed with ADHD+ODD, one group with ADHD only, one group with ODD only, and one group with neither disorder. Using subscales from the mother-report Social Skills Rating System (SSRS) (Gresham & Elliott, 1990) and the teacher-report Pupil Evaluation Inventory (PEI) (Pekarik, Prinz, Liebert, Weintraub, & Neale, 1976), the authors found that membership in the various disordered groups was associated with different social deficits. More specifically, the ODD and ADHD+ODD groups were rated significantly lower on the self-control scale of the SSRS than the ADHD group. In contrast, children with ADHD were rated as

more disruptive than the other groups, whereas, children with ODD were rated as showing less respect than the other children. Matthys and colleagues (1999) investigated social problem-solving in aggressive children who were grouped according to DSM-III-R diagnostic criteria. Five groups were identified for the purposes of the study: an ODD/CD group, an ADHD group, an ODD/CD+ADHD group, psychiatric control group, and a normal control group. Results indicated that children with ADHD exhibited deficits in encoding cues and response generation. However, both of these social skills were affected in the ODD/CD and ODD/CD+ADHD groups as well suggesting that some social skill deficits are indeed common across the disruptive behavior disorders.

In summary, mixed findings still abound in the literature regarding the specific associations between social competence and symptoms of ADHD and ODD. Methodological inconsistencies such as failing to account for comorbidity, grouping ODD and CD in a generic category of "conduct problems", using different grouping criteria, studying different aspects of social competence, and employing a variety of different measures are likely explanations for these conflicting findings. The current study aims to provide further clarification regarding the differential relations of social competence with symptoms of ADHD, ODD, and ADHD+ODD. By examining the association between social outcomes in middle childhood (at 6th grade) and trajectories of ADHD and ODD symptoms ranging from 3rd to 6th grade in a community sample of boys and girls, we aim to circumvent some of the past limitations found in the research literature. For example, the trajectory groups will be described using DSM-IV symptoms and comorbid symptomatology will be controlled in the analyses. Furthermore, the present study will examine two aspects of social competence: social skills and friendship quality. Social skills, including cooperation, assertion, responsibility, and self-control, will be assessed using a

common measure, the SSRS, administered to both the child's teacher and mother. Finally, child-reported friendship quality, which is currently understudied (see for review: Normand, Schneider, & Robaey, 2007), will also be examined.

1.5.2 Academic performance

Prior research has documented a strong connection between symptoms of ADHD and learning in preschool and middle-school children (see for reviews: Brassett-Harknett & Butler, 2007; Hinshaw, 1992; Spira & Fischel, 2005). Overall, the literature indicates that children with elevated levels of ADHD symptoms are at increased risk for academic difficulties, including learning disabilities, academic underachievement, and reading deficits. Although the relation between ADHD symptoms and academic difficulties has been established, the nature of the relationship remains uncertain. For example, based on his review of the literature, Hinshaw (1992) concluded that symptoms of *aggression*, as well as inattention and hyperactivity, are linked to reading underachievement in early and middle childhood. In fact, delinquent behavior has traditionally been associated with school learning difficulties (Broder, Dunivant, Smith, & Sutton, 1981; Wilgosh & Paitich, 1982). Unfortunately, these older studies failed to control for comorbid disorders; therefore, their results do not indicate whether learning problems are specifically associated with symptoms of ODD, CD or ADHD. Furthermore, these studies did not control for other known correlates of learning problems, such as IQ, SES, and prior learning performance, obscuring the nature of the relation between disruptive behavior disorder symptoms and academic functioning even further.

Subsequent studies have attempted to unravel these different relationships (Cunningham & Boyle, 2002; Frick et al., 1991; Kuhne et al., 1997; Loeber, Green, et al., 2000; Rabiner, Coie,

& Conduct Problems Prevention Research Group, 2000). Rabiner and colleagues (2000) examined the relation between various dimensions of behavior problems (i.e. attention, hyperactivity, internalizing, and externalizing problems) with reading performance in children from kindergarten to 5th grade, while controlling for common correlates. Using a longitudinal design and a community sample, the authors found that only attention problems predicted children's reading achievement after controlling for IQ, prior reading achievement, and parental involvement. In contrast, based on their review of the findings from the first decade of the Developmental Trends Study which followed clinic-referred samples of boys ranging from 7- to 19-years of age over a 6 year period, Loeber, Green and colleagues (2001) reported that academic underachievement was associated with DSM-III and DSM-III-R ADHD symptoms more generally (i.e., not just inattention), but not with CD symptoms, after controlling for potential comorbidity.

Kuhne and colleagues (1997) reported slightly different results when they examined the association with academic difficulties in 5- to 12-year-old children grouped using DSM-III-R criteria into a "pure" ADHD group, an ADHD group with comorbid ODD (ADHD+ODD), and an ADHD group with comorbid CD (ADHD+CD). Using a mean score on the WRAT reading, spelling and arithmetic scales as their index of academic achievement, Kuhne et al. reported no significant differences between the ADHD and ADHD+CD groups. However, somewhat unexpectedly, they found that children with ADHD+ODD performed significantly better than children in the ADHD only group. The authors concluded that while ADHD may play a role in academic underachievement, the presence and type of comorbid condition may also influence performance. In contrast, Cunningham and Boyle (2002) found that preschool children with elevated DSM-III-R symptoms of ADHD exhibited more pervasive difficulties at school than

their peers with high levels of ODD or CD symptoms. The inconsistent results generated by these more recent studies are most likely due to variations in methodology and design. Each study used a different set of grouping criteria ranging from DSM diagnoses to symptom criteria, examined different aged samples, and employed measures assessing different aspects of academic performance.

Overall, recent and past research supports an association between symptoms of ADHD and academic difficulties. Even though recent literature has attempted to illuminate the nature of this relation by examining the effect of potential confounding variables, such as comorbidities, prior behavior and learning problems, as well as a range of psychosocial correlates, they have reported mixed results. The current study aims to elucidate the relation between symptoms of ADHD, ODD and ADHD+ODD with academic performance by using DSM-IV symptom criteria, a large community sample, and controlling for co-morbid symptoms.

2.0 STATEMENT OF PURPOSE

Prior research has shown that high levels of ADHD and ODD symptoms co-occur at rates greater than chance. In addition, although the importance of investigating the developmental course of symptoms and disorders has been emphasized in the developmental psychopathology literature, few studies have examined both ADHD and ODD symptoms longitudinally in the same study to ascertain developmental changes in symptom patterns or their co-occurrence across time. Understanding how symptoms vary and co-occur over time would provide several benefits. First, it would provide insight into the continuity and discontinuity, as well as the developmental pattern of these symptom clusters. Second, it would provide the opportunity to examine how levels of ADHD and ODD symptoms co-vary over time. Third, investigating the predictors and outcomes of developmental trajectories of symptoms, as opposed to correlates of symptoms at one point in time, would provide the opportunity to examine questions of multifinality and equifinality.

Furthermore, the extant research literature documents significant associations between elevated symptoms of ADHD and ODD across middle childhood and deficits in children's cognitive, academic and social functioning; both ADHD and ODD symptoms have also been associated with adverse external factors, such as less supportive parenting and harsh parenting. Unfortunately, much of this research has neglected to account for the likely co-occurrence of either ADHD or ODD symptoms. Because children exhibiting high levels of ODD symptoms

and those showing elevated ADHD symptoms show similar deficits, it is unclear whether ADHD, ODD or their combination are driving these associations.

Clarifying the associations between child characteristics and psychosocial factors that predict elevated symptoms of ADHD, ODD, or their combination, is vital for identifying children for prevention and intervention purposes. Similarly, identifying which combinations of ODD, ADHD, and ADHD+ODD symptoms are associated with specific outcomes, such as academic difficulties and social deficits, elucidates domains of functioning that should be targeted in intervention programs.

In addition to the various ways that researchers have, or have not, chosen to account for comorbid symptoms of ADHD and ODD or their temporal variations, several other methodological factors and limitations may also account for the mixed results reported in the literature. Many previous studies are limited by their use of samples that span wide age ranges. As certain predictors and outcomes may be differentially associated with elevated symptoms at different points in development, interpreting the results of these studies becomes difficult. Other methodological factors that pose obstacles to comparing results across studies include the nature of the sample (i.e. whether it was recruited from a clinical or community setting), and widely diverging selection criteria, such as DSM diagnoses, DSM symptom levels, or more general behavior rating scales. Utilizing a community sample avoids the self-selection bias that is inherent in using a clinical sample, and thus ensures greater generalizability of results. Furthermore, in the current study we employ a behavior rating scale based on DSM symptoms because employing behavior rating scales that are not tied to current DSM criteria introduces ambiguity regarding the similarity of the behaviors being studied. Consequently, caution should be exercised when generalizing results from such studies to the DSM symptom complexes of

ADHD and ODD. In summary, a study using a longitudinal prospective design and including a community sample, multi-informant measures of DSM-IV symptoms, as well as measures of child and family functioning, would provide an opportunity to examine the differential associations between developmental trajectories of ADHD, ODD, and ADHD+ODD symptoms with potential predictors and outcomes while avoiding some of the methodological pitfalls that currently plague the literature.

To this end, the proposed study will first identify longitudinal patterns of DSM-IV symptoms of ADHD, ODD, and ADHD-ODD from 3rd to 6th grades in a community sample, recruited for the NICHD Study of Early Child Care and Youth Development, and followed from birth to 12 years of age. A person-centered, semi-parametric group-based modeling approach (Nagin, 1999) will be used to describe not only the developmental course of ADHD and ODD symptoms across middle childhood, but also their co-occurrence. Secondly, analyses will be conducted examining the differential associations between multi-informant measures of child- and family-based predictors and outcomes. Based on the research reviewed earlier, children's executive functioning is expected to predict elevated symptom trajectories of ADHD and ADHD+ODD, but not elevated trajectories of ODD alone. In addition, family variables such as maternal sensitivity and harsh discipline are expected to predict elevated ODD and ADHD+ODD symptoms. Finally, a last set of analyses will be conducted to examine whether children's social and academic outcomes at age 12 (6th grade) differ significantly by trajectory group. As suggested by the literature, academic underachievement and poor social skills are expected to be associated more strongly with elevated ADHD and ADHD+ODD symptoms than with ODD symptoms alone.

3.0 HYPOTHESES

3.1 HYPOTHESIS 1A: TRAJECTORIES OF ADHD SYMPTOMS IN ELEMENTARY SCHOOL (3RD TO 6TH GRADE)

Based on previous research, it is hypothesized that at least three trajectories of ADHD symptoms will be identified, with the majority of children in this community sample exhibiting low levels of ADHD symptoms between 3rd and 6th grades. A second group of children exhibiting high levels of ADHD symptoms across time will also be identified. A third group showing of children exhibiting decreasing symptoms is also likely to be identified. This pattern of declining symptoms over time is expected because hyperactive-impulsive and inattentive behaviors are likely to decrease in a subset of children as their regulatory abilities mature over time. It is also possible that a group showing increasing and/or variable levels of symptoms will emerge from the data.

3.2 HYPOTHESIS 1B: TRAJECTORIES OF ODD SYMPTOMS IN ELEMENTARY SCHOOL (3RD TO 6TH GRADE)

It is hypothesized that four distinct patterns of ODD symptom will be found. The first trajectory group will include the majority of the community sample who will display low levels of ODD symptoms across time. The smallest number of children will present with high levels of ODD symptoms that remain elevated from 3rd to 6th grade. Finally, two other groups are expected, exhibiting symptom levels that fall in between the high stable and low stable groups. One of these trajectory groups will exhibit a pattern of increasing levels of ODD symptoms over time, whereas the other group will show the reverse, i.e. decreasing levels of ODD symptoms over time.

3.3 HYPOTHESIS 1C: DUAL TRAJECTORIES OF ADHD AND ODD SYMPTOMS IN ELEMENTARY SCHOOL (3RD TO 6TH GRADE)

ADHD and ODD have been found to co-occur at a rate significantly greater than chance. Therefore, it is proposed that a substantial proportion of the children exhibiting elevated levels of ADHD symptoms across time will also exhibit high levels of ODD symptoms across time. There will also be some children who exhibit high levels of either ADHD or ODD symptoms exclusively. However, it is expected that the majority of children in this community sample will display both low levels of ADHD and ODD symptoms.

3.4 HYPOTHESIS 2A: EARLY CHILD AND PARENTING FACTORS WILL PREDICT LATER ADHD AND ODD TRAJECTORY MEMBERSHIP DIFFERENTIALLY

It is hypothesized that child factors assessed at preschool age and first grade (i.e., inhibition deficits, inattention, delay, and planning deficits) will predict higher levels of ADHD symptoms after controlling for concurrent levels of ODD symptoms. In line with previous research, it is expected that ODD group membership will not be differentially predicted by executive function deficits after controlling for concurrent ADHD symptoms.

Furthermore, as suggested by prior research, it is proposed that certain parenting factors (e.g., harsh maternal control and low maternal sensitivity) will predict higher levels of ODD and ADHD+ODD symptoms across time. As the research literature appears to be unclear as to the relation between parenting factors and symptoms of ADHD, no specific predictions will be made regarding this association.

3.5 HYPOTHESIS 2B: EARLY CHILD AND PARENTING FACTORS WILL PREDICT LATER DUAL TRAJECTORY MEMBERSHIP

Based on research indicating that high levels of both ADHD and ODD symptoms are best conceptualized as an additive combination of ADHD and ODD symptoms alone, it is hypothesized that elevated dual trajectories will be significantly associated with both child and parenting predictors. In keeping with the additive conceptualization, elevated dual trajectories are expected to be associated with higher levels of these risk factors.

3.6 HYPOTHESIS 3A: ACADEMIC AND SOCIAL OUTCOMES AT SIXTH GRADE WILL BE ASSOCIATED WITH ADHD AND ODD TRAJECTORY GROUP MEMBERSHIP AFTER CONTROLLING FOR CONCURRENT ODD AND ADHD SYMPTOMS RESPECTIVELY

It is expected that poor academic achievement at 6th grade will be associated primarily with elevated levels of ADHD, rather than ODD symptoms. Furthermore, in line with previous findings that children with elevated levels of hyperactive –impulsive and inattentive symptoms experience significantly more peer difficulties than children presenting with elevated levels of conduct problems (Waschbusch, 2002), it is hypothesized that poor friendship quality and social competence will be more strongly associated with high ADHD, than high ODD, symptom levels.

3.7 HYPOTHESIS 3B: ACADEMIC AND SOCIAL OUTCOMES WILL BE DIFFERENTIALLY ASSOCIATED WITH THE DUAL TRAJECTORY GROUPS

Again, based on previous research, it is expected that there will be an additive effect when high levels of ADHD symptoms and high levels of ODD symptoms co-occur. This additive effect will be reflected in a significant association between membership in the elevated dual trajectory group and high levels of academic underachievement, low friendship quality, and social competence.

4.0 METHOD

4.1 PARTICIPANTS

The analyses for this study are based on data from 1081 families, who are a subset of those participating in the longitudinal, multi-site NICHD Study of Early Child Care and Youth Development. Children participating in this study were born in 1991 in hospitals at 10 data collection sites across the U.S.: Little Rock, AR; Irvine, CA; Lawrence, KS; Boston, MA; Philadelphia, PA; Pittsburgh, PA; Charlottesville, VA; Morganton, NC; Seattle, WA; and Madison, WI. These children and their families were followed from birth through sixth grade.

Families were recruited during hospital visits to mothers shortly after their child's birth. During selected 24-hour sampling intervals, 8,986 women giving birth were screened for eligibility and willingness to be contacted again. Of these women 5,416 (60%) agreed to be called in 2 weeks and met the following eligibility criteria: the mother was over 18 years of age and could speak English; the family did not plan to move within the next three years; the child was a singleton, was not hospitalized for more than 7 days, and did not have obvious disabilities; the mother did not have a known substance abuse problem. A total of 1,364 mothers, who completed a home interview when their infant was 1 month old, became the study participants. The recruited sample was diverse, including 24% ethnic minority children, 11% mothers with

less than a high school education, and 14% single mothers. More details on sample recruitment and methods can be found at the study website (http://secc.rti.org/).

Of the 1,364 participants constituting the original sample, 1081 mothers and children were included in the current study. They were selected because maternal and/or teacher reports of ADHD and ODD symptoms were available at a minimum of two (out of a possible four) assessment points between third and sixth grades. Attrition analyses, comparing study families who were not included in the trajectory analyses due to missing ADHD and ODD symptom data (N = 283) with those families who were, revealed significant differences between groups (see Table 1). Based on the one month home visit, mothers who were included in this study were more educated (M = 14.44 *vs.* 13.54 years, $F = 32.00$, $p < .000$), older ($M = 28.51$ *vs.* $M = 26.76$, $F = 23.84$, $p < .000$), and had more financial resources (M = 2.91 *vs.* 2.27, F = 13.38, $p <$ .000) than those who were not included. In addition, included families were more likely to be Caucasian than any other ethnicity (81% *vs.* 19%). The above analyses indicate that the sample for the current study has significantly more financial and academic resources than families who were not included due to missing data.

Table 1. Demographic variables for the study sample and the sample of excluded participants

	Final Sample (*N* = 1081)				Excluded Participants (*N*=283)			
Demographic Variables	*N*	%	*M*	*(SD)*	*N*	%	*M*	*(SD)*
Child Sex								
Male	543	50.2			162	57.2		
Female	538	49.8			121	42.8		
Child Ethnicity								
Caucasian	880	81.4			217	76.7		
Minority	201	18.6			66	23.3		
Maternal Education			14.43	(2.45)			13.48	(2.62)
Less than 12 years	90	8.4			49	17.4		
High School or GED	572	52.9			170	60		
Bachelor's degree	248	22.9			36	12.7		
Postgraduate work	171	15.8			27	9.5		
Income to Needs Ratio[a]			3.68	(2.83)			3.19	(2.92)
> 2.0	773	71.5			136	48.1		
$\leq$ 2.0[b]	301	27.8			92	32.5		
Marital Status[c]								
Stably married	690	63.8			47	16.6		
Not stably married	390	36.1			236	83.4		

[a] Mean income-to-needs collected at 6, 15, 24, 36, and 54 months; *n* = 1074 as 7 participants refused to provide income data at any time point.
[b] Scores below or equal to poverty threshold.
[c] *N* = 1080 as 1 participant refused to supply data at any of the time points between 6 and 54 months.

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4.2 PROCEDURES

Data were initially collected when the children were 1 month old and again at 6, 15, 24, 36, 54 months and at first, second, third, fourth, fifth and sixth grades (age 7, 8, 9, 10, 11, and 12 years respectively). Home visits were conducted when the study children were 1 month old. During this visit, demographic information including maternal education level, mother's marital status, child sex and ethnicity, and the family's income to needs ratio (see below) was collected. Demographic data on the family were updated during phone calls and face-to-face contacts with mothers at regular intervals through first grade.

Maternal and teacher reports of children's ADHD and ODD symptoms were obtained using the Disruptive Behavior Disorder Scale during third, fourth, fifth, and sixth grades. Observations of mother-child interaction were obtained in the home at 6 and 15 months and in the laboratory at 24, 36, and 54 months. During the home visit at 54 months, mothers were asked to report on their discipline strategies. Executive function measures were administered in the laboratory when the children were 54 months of age and during a home visit at first grade. Child outcome measures at sixth grade were obtained during a laboratory visit and from teacher and mother reports.

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4.3 MEASURES

A range of measures of child and family functioning were obtained over the course of the study. Several early measures will be conceptualized as predictors and measures obtained at sixth grade will be conceptualized as outcomes of trajectory membership. In order to facilitate interpretation and reduce the number of variables used in the analyses, identical indicators using both mothers and teachers as informants will be transformed to create composites when applicable. Additional details about all data collection procedures, psychometric properties of the instruments, and descriptions of how composites were derived are documented in the study's Manuals of Operation (http://secc.rti.org).

4.3.1 Demographic and other control variables

Maternal Education. During the one month home interview, mothers reported on the number of years of school completed; this was used as an index of maternal education.

Child Gender. Mothers reported the gender of their child during the one month home visit.

Child Ethnicity. Child ethnicity was reported by the mother during the one month home visit. The original score ranging from 1 to 5 (1 = American Indian, 2 = Asian or Pacific Islander, 3 = Black or Afro-American, 4 = White, and 5 = Other) was transformed into a categorical score. Children who were originally identified as a 1, 2, 3, or 5 were grouped together into a Minority category while the remaining children, who were identified as White, were relabeled into a Caucasian ethnicity group.

Marital Status. During interviews from 1 month through 54 months, mothers reported their marital status. Mothers who identified themselves as married at each time point were considered *stably married*, whereas mothers who reported that they were single, separated, divorced, widowed, or living with a domestic partner at any time point were labeled as *not stably married*.

Income-to-needs Ratio. Information about family income was collected when study children were 6, 15, 24, 36 and 54 months old. The income-to-needs ratio measures the total family income divided by the poverty threshold according to size of family (NICHD Early Child Care Research Network, 1997). The average income-to-needs ratio from 6 to 54 months will be used in the analyses to control for disparities in family income.

4.3.2 Measures of symptom trajectories

4.3.2.1 Mother and teacher reported symptoms of ADHD and ODD

Disruptive Behaviors Disorder Rating Scale (DBD). At 3rd, 4th, 5th and 6th grades, teachers and mothers were asked to rate study children on the 18 DSM-IV symptoms of ADHD and the 8 DSM-IV symptoms of ODD (American Psychiatric Association, 1994). This measure is an adaptation of the original Disruptive Behavior Disorders (DBD) Rating Scale (Swanson et al., 2001). Each behavior was rated on a 4-point scale: 0 = not at all, 1 = just a little, 2 = pretty much, and 3 = very much a problem. Items were recoded so that the original values of 0 and 1 were recorded as 0 = symptom not present, while the values of 2 and 3 were reentered as 1 = symptom present. These scores were then summed resulting in a symptom count representing the total number of DSM-IV symptoms attributed to the study child by their mother and/or teacher.

Next, the HI and IA symptom scores were summed to create an overall ADHD symptom count. Overall, these symptom scores were found to have moderate to high internal reliability (ADHD symptoms according to mothers and teachers from 3rd to 6th grades: Cronbach's alphas ranged from 0.81 and 0.90; ODD symptoms according to mothers and teachers from 3rd to 6th grades: Cronbach's alphas ranged from 0.74 to 0.89). The average of the teacher- and mother-reported ADHD symptom count scores and ODD symptom count scores at each grade (3rd - 6th) were used in the trajectory analyses. If ratings were missing from one of the reporters, the available mother or teacher scores were used on their own; Table 2 depicts score informant information for ADHD and ODD symptoms at each time point. When looking at the associations between the ADHD symptom trajectory groups and predictor and outcome variables, the potentially confounding effect of comorbid ODD symptoms was controlled statistically by entering the average of the categorical ODD symptom count scores between 3rd and 6th grades into the analysis. The effect of ADHD symptoms on the relations between ODD symptom trajectories and potential predictor and outcome variables was controlled in the same manner. Finally, it is important to note that the DBD does not include additional diagnostic criteria such as age at symptom onset or functional impairment; therefore the symptom count scores do not represent a clinical diagnosis.

Table 2. Informant source of child symptom ratings from 3rd through 6th grade

Informant	Grade			
	3rd	4th	5th	6th
ADHD Symptoms				
Mother	102	143	130	183
Teacher	55	38	33	18
Mother and Teacher	925	877	889	836
ODD Symptoms				
Mother	104	148	136	189
Teacher	55	38	34	22
Mother and Teacher	923	874	882	829

4.3.3 Predictors of ADHD and ODD symptoms

4.3.3.1 Parent factors

Observations of Maternal Sensitivity. Mother-child interactions were observed in the home at 6 and 15 months and in the laboratory at 24, 36, and 54 months. At the 6 and 15-month home visits, interactions were videotaped during 15 minutes of semi-structured play. Similarly, at 24, 36, 54 months mother-child interaction during play was videotaped during the laboratory visit. At each age different sets of age-appropriate toys and activities were selected to elicit joint play. Mothers were instructed to play with the toys in a fixed order. Further details may be found in prior publications (NICHD Early Child Care Research Network, 1999, 2003). The videotapes of mother-child interactions were sent to a central, non-data collection site for coding. Coders received training and ongoing supervision at regular meetings to ensure reliability. They were blind to any information about study families; videotapes were randomly assigned to coders (NICHD Early Child Care Research Network, 1999). Mothers' behaviors during the 6, 15, and 24 month visits were rated on 4-point scales of sensitivity to non-distress, positive regard, and intrusiveness during play. The scores ranged from 1 (not at all characteristic of the interaction) to 4 (highly characteristic of the interaction). At each age, scores on the three scales (sensitivity to non-distress, positive regard, and intrusiveness reversed) were summed to form the composite score of maternal sensitivity during play. Intraclass correlations were used to calculate inter-observer reliability on the composite scores. Reliabilities averaged across pairs of raters were .87 at 6 months, .83 at 15 months, and .85 at 24 months. Cronbach's alphas for the composite scores were .75, .70, and .79, respectively (NICHD Early Child Care Research Network, 1999).

Mothers' behaviors during the 36 and 54 month visits were rated on three conceptually similar but developmentally more appropriate 7-point scales: supportive presence, respect for autonomy, and hostility. The scores ranged from 1 (not at all characteristic of the interaction) to 7 (highly characteristic of the interaction). At each age, the sum of the scores on these three scales (supportive presence, respect for autonomy, and hostility reversed) formed the composite score of maternal sensitivity during play. Intraclass correlations averaged across pairs of raters were .84 at 36 months, .88 at 54 months, and .91 at first grade. Cronbach's alphas for the composite scores were .78, .84, and .82, respectively (NICHD Early Child Care Research Network, 2003). Because mothers' behaviors were measured on 4-point scales at 6, 15, and 24 months and on 7-point scales at later ages, scores were transformed into Z scores and then averaged across time points.

Harsh Maternal Control. Mothers completed the Raising Children Questionnaire assessing parental discipline strategies when the study child was 54 months of age. This questionnaire is a revision of Greenberger's Raising Children Checklist (Greenberger & Goldberg, 1989) and was developed for use in the NICHD Study of Early Child Care and Youth Development by Shumov, Vandell, and Posner (1998). The modified instrument includes 28 statements designed to assess parenting strategies along three dimensions: harsh, firm, and lax control. Response options ranged from 1 = "Definitely No" to 4 = "Definitely Yes." The three measured dimensions of parenting were created to correspond to authoritarian (harsh), authoritative (firm), and permissive (lax) styles of parenting discussed by Baumrind and Black (1967).

In the current study, the Harsh Control Score was used as an index of harsh (authoritarian) maternal parenting. This score was computed by summing the responses to eight

items; higher scores signify a harsher degree of parental control. This scale has modest internal reliability (Cronbach's alpha = 0.71). Items included questions such as, "Do you think that respect for authority is the most important thing your child should learn," and "Do you expect your child to be quiet and respectful when adults are around?"

4.3.3.2 Child factors: Executive function measures

Continuous Performance Task (CPT). At 54 months, children were individually administered the CPT towards the end of a 2-hour lab visit. The child was seated in front of a 2-inch square screen and a red button. Dot matrix pictures of familiar objects, such as butterflies, fish or flowers, were generated by a computer and presented consecutively on the screen. The child was instructed to press the red button each time a previously identified target stimulus (a chair) appeared on the screen.

Once the test session began, the stimuli were presented in 22 blocks. Each block contained 10 stimuli resulting in a total display of 220 stimuli over the course of the test. The stimulus was flashed on the screen for 500 msec and the interstimulus interval (ISI) lasted for 1500 msec before the next stimulus appeared. Within each block of stimuli, the target stimulus was presented twice at random. The entire test lasted for approximately 7 minutes and 20 seconds.

The computer automatically provided scores on the number of times the child responded to a non-target stimulus (errors of commission), traditionally considered to represent impulsive responses or deficient behavioral inhibition (Barkley & Grodzinsky, 1994; Epstein et al., 2003). Information was also provided on the number of times the child failed to respond to a target stimulus (errors of omission), which are commonly used as a measure of inattention (Halperin, Sharma, Greenblatt, & Schwartz, 1991).

Delay of Gratification Task (DGT). On the DGT, behavioral inhibition is operationalized by the ability to resist choosing an immediate smaller reward in lieu of a larger delayed reward. The DGT was administered during the 54 month laboratory visit and was modeled on Mischel's (1974, 1981) self-imposed waiting task .

Before the DGT was administered, the visit coordinator (VC) issued four sets of instructions to the child. First, the child was taught how to ring the bell, and the VC explained that s/he was going to leave the room and could be summoned back when the child rang the bell. This procedure was practiced before the experiment began. Second, the VC established which food (i.e. M&Ms, animal crackers or pretzels) the child would like to have as a reward. Third, the VC determined whether the child preferred to have a small amount or a larger amount of his/her favorite food for a reward. Finally, after the VC determined that the child preferred a larger quantity of his or her chosen food, the VC provided the following explanation of how to play the "waiting game." The VC told the child that s/he would play the waiting game while the VC was out of the room for a few minutes doing some work. Two plates were left in the room with the child, one holding a small pile of food and the other holding a larger pile of food. The VC told the child that s/he would be able to eat the larger amount of the desired food, if s/he was able to wait until the VC returned to the room, without the child summoning her back. In the event that the child was unable to wait for the VC to return, s/he was told that s/he could ring the bell. However, the child was warned that if s/he summoned the VC back into the room by ringing the bell s/he would receive the smaller amount of food. The child was also told to remain seated in his/her chair while the VC was out of the room and not to eat any of the food until the VC returned.

After delivering these instructions the VC left the room and entered an observation booth to watch the child. If the child successfully waited for 7 minutes, the VC returned, praised the child, and rewarded him/her with the larger pile of food. If the child did not use the bell but proceeded to eat any of the food, the amount of elapsed time was recorded and the VC returned to the room giving the child the smaller pile of food. If the child spontaneously ate the food, but also did not display convincing evidence that s/he comprehended the waiting rules to begin with, this child's data were treated as "missing" (i.e. no waiting time was entered on the scoring sheet). The amount of time the child waited after the VC left the room was used to operationalize behavioral inhibition in the current study.

Tower of Hanoi (TOH). Planning was assessed during the home visit at 1st grade using the Tower of Hanoi (Klahr & Robinson, 1981). Children were administered up to six puzzles of increasing difficulty which involved moving three rings varying in diameter and color among three vertical pegs to copy a model of a tower in the fewest possible moves. The largest ring always had to be on the bottom. Movement of the rings was further constrained by three rules: only one ring could be moved at a time; larger rings could not be placed on smaller rings; and, a ring had to be on a peg or in the player's hand. A maximum of 20 moves was allowed to solve a trial. If children solved the trial in less than the optimal number of moves they were encouraged to try to solve the puzzle in a smaller number of moves. After two consecutive optimal solutions of a given puzzle, a more difficult puzzle was started. The entire task was terminated when the child was unable to complete a puzzle twice in succession in the fewest number of moves. Performance was operationalized by the Total Planning Efficiency Score (Cronbach's alpha = .70), representing the number of moves the child needed to complete each trial; higher scores reflected better planning skills.

4.3.4 Outcome measures

4.3.4.1 Academic performance

Academic Rating Scales from the Early Childhood Longitudinal Study. At 6th grade, teachers were asked to rate the study child's skills, knowledge, and behaviors in one area of academic learning: language and literacy. The teacher rated the child's performance on 10 items assessing listening, speaking, reading, and writing behaviors; items were rated on a 5-point scale ranging from 1 = "Not Yet" to 5 = "Proficient"; the 10 items had high internal reliability (Cronbach's alpha = 0.94). The Total Language and Literacy score was calculated by averaging the scores for the 10 items. In the current study the Language and Literacy score was used as a measure of children's academic performance, with higher scores indicated better language and literacy skills.

4.3.4.2 Social competence

Friendship Quality. At 6th grade, study children completed the Friendship Quality Questionnaire (Parker & Asher, 1993) assessing their perception of their friendship with their best friend. Using a 5 point scale (1 = "Not at all true," 2 = "A little true," 3 = "Somewhat true," 4 = "Mostly true", and 5 = "Really true"), study children were instructed to rate 29 statements describing their relationship with their best friend. The 29 item questionnaire included questions pertaining to six qualitative aspects of the child's friendship: companionship and recreation, validation and caring, help and guidance, intimate disclosure, conflict and betrayal, and conflict resolution. A Friendship Quality Total score was computed as the mean of the responses; this score was used in the current study as a measure of friendship quality (Cronbach's alpha = .93).

Social Skills Rating System (SSRS). Mothers and teachers completed the SSRS at 6th grade (Gresham & Elliot, 1991). This questionnaire includes 30 items assessing the child's social skills such as sharing, helping, initiating relationships, and controlling one's temper. Items are rated on a 3 point scale (0 = never, 1 = sometimes, 3 = very often). This measure has high internal consistency (Cronbach's α = .88 for mothers and .93 for teachers). An average of the Social Skills Total Standard Score (*M*=100, *SD*=15) as reported by mother and teacher was used as a measure of social competence in the current study, with the higher scores representing higher levels of socially competent behavior.

5.0 DATA ANALYTIC PLAN

Analyses were conducted in stages in accordance with the hypotheses outlined above. First, separate trajectories of DSM-IV symptoms of ADHD and ODD were identified using a semiparametric group-based approach to modeling developmental trajectories, TRAJ, which is a specialized application of finite mixture models (Nagin, 1999, 2005). A priori hypotheses regarding the number of expected trajectories (see first hypothesis) provided a theoretical frame for the model selection. Based on the hypothesized number of trajectory groups, an upper limit was placed on the number of possible groups and then all of the model possibilities within that limitation were explored. Decisions about the optimal model fit were also based on three output criteria: the statistical significance of the polynomial function parameter estimate; the Bayesian Information Criterion (BIC); and the posterior (conditional) probability of membership in each group for each individual.

First, the statistical significance of each of the polynomial function parameters (i.e., cubic, quadratic, linear, or zero-order) was used to determine the shape (i.e. the change in symptoms levels over time) of each trajectory within each model tested. The Bayesian Information Criterion (BIC) was then examined because it employs empirical methods for identifying the best model. The model with the maximum BIC in conjunction with the fewest groups is preferred (Nagin, 2005). In addition to the BIC, the selection of the appropriate model was guided by the posterior probability scores for each trajectory group. Posterior probability

scores are generated by TRAJ. These scores provide a measure of how closely each participant's scores fit those of their assigned trajectory group, thereby, indicating the probability that the person belongs in one trajectory group and not another. In this manner, they provide a statistical basis for assigning individuals to trajectory groups (Nagin, 1999). We utilized Nagin's suggested criteria as follows: an average probability score of .80 or above was preferred and a score below .70 was considered unacceptable (Nagin, 2005).

After the individual trajectory analyses were completed, we planned to modify this group-based modeling approach in order to examine the association between the developmental trajectories of ADHD symptoms and ODD symptoms. The dual trajectory model uses the parameter estimates of the previously defined best-fit ADHD symptom model and best-fit ODD symptom model to calculate: 1) the trajectories for each behavior (ADHD symptoms and ODD symptoms), 2) the trajectory group membership probabilities for each behavior, and 3) the probabilities of joint trajectory group membership across both symptom models

Once the trajectory analyses were completed, several follow-up analyses were conducted to address additional study hypotheses. First, relevant demographic and family correlates including child gender, child ethnicity, maternal education, marital stability and mean income-to-needs were examined as a function of trajectory group. These analyses were performed both to describe and differentiate the trajectory groups qualitatively as well as to identify potential confounding covariates which were subsequently controlled in later analyses. Second, multinomial and binary logistic regressions were conducted examining child and parenting variables as potential predictors of individual trajectory group, and dual group, membership, controlling for comorbidity. Finally, the association between individual and dual trajectory membership and children's social and academic outcomes was investigated at sixth grade. Data

imputation using expectation maximization in SPSS was utilized to deal with missing data on demographic, child and parent predictor, and child outcome variables: this method uses a maximum likelihood approach (Dempster, Laird, & Rubin, 1977). As mentioned above, sociodemographic and family context variables that differed significantly across trajectory groups, and also accounted for a significant proportion of variance in the majority of analyses of interest, were entered as covariates in order to target the association of interest.

6.0 RESULTS

Results are presented as follows: 1) descriptive statistics and bivariate intercorrelations for study variables; 2) individual and joint trajectory models; 3) examination of child and parenting factors as predictors of trajectory groups; 4) association between trajectory group membership and later measures of social skills and academic performance. In the service of facilitating interpretation, and in line with the structure of the discussion, descriptive analyses examining sociodemographic and family context variables as a function of individual trajectory groups (illuminating qualitative differences between the different trajectory groups) are presented after the relevant trajectory analyses.

6.1 DESCRIPTIVE STATISTICS AND BIVARIATE CORRELATIONS

Descriptive statistics are presented in Table 3 and bivariate correlation coefficients between sets of study variables are presented in Tables 4 – 7. Correlations between mother and teacher reported ADHD symptom counts from 3rd to 6th grade are shown in Table 4. As would be expected mother reports of symptoms are moderately and significantly correlated across time (r =.61 to r = .76, $p \leq .01$). Although teacher reported ADHD symptoms are not as highly correlated as mother reports, they are still significantly correlated across time (r =.47 to r = .55, $p \leq .01$), despite that fact that different teachers were involved at each grade. Mother and teacher

reports of ADHD symptoms likewise are modestly and significantly correlated at each time point (r =.37 to r = .46, $p \leq .01$), and also over time (r =.29 to r = .42, $p \leq .01$).

Table 3. Descriptive statistics for study variables

Variables	*N*	Mean	*SD*	Range
ADHD Symptoms				
3rd grade	1061	2.47	3.30	0 – 16.50
4th grade	1059	2.46	3.93	0 – 18.00
5th grade	1052	2.66	4.00	0 – 18.00
6th grade	1040	2.70	4.10	0 – 18.00
ODD Symptoms				
3rd grade	1061	0.57	1.13	0 – 8.00
4th grade	1059	0.53	1.15	0 – 8.00
5th grade	1052	0.59	1.15	0 – 8.00
6th grade	1040	0.54	1.17	0 – 8.00
Predictors: Parent Factors				
Maternal Sensitivity	1075	0.02	0.73	-3.07 – 1.57
Harsh Control	988	21.15	3.32	12 – 30
Predictors: Child Factors				
CPT Omission Errors	937	9.01	7.54	0 – 41.07
CPT Commission Errors	937	13.87	21.04	0 – 154
Delay of Gratification	898	4.51	2.99	0 – 7
Tower of Hanoi	949	14.38	6.77	0 – 34
Outcomes Variables				
Academic Performance	863	3.79	0.92	1 - 5
Friendship Quality	999	4.21	0.59	1.79 – 5.00
Social Skills	1040	105.40	13.06	65 – 130

Table 4. Intercorrelations among mother and teacher reported symptom counts of ADHD

	1	2	3	4	5	6	7	8
1. ADHD Sx – Mother Report, GR 3	--	.74*	.68*	.61*	.46*	.40*	.35*	.29*
2. ADHD Sx – Mother Report, GR4		--	.75*	.73*	.42*	.45*	.37*	.34*
3. ADHD Sx – Mother Report, GR 5			--	.76*	.37*	.41*	.37*	.32*
4. ADHD Sx – Mother Report, GR 6				--	.35*	.36*	.36*	.38*
5. ADHD Sx – Teacher Report, GR 3					--	.55*	.47*	.49*
6. ADHD Sx – Teacher Report, GR 4						--	.50*	.48*
7. ADHD Sx – Teacher Report, GR 5							--	.50*
8. ADHD Sx – Teacher Report, GR 6								--

* $p \leq .01$.

Table 5 contains the intercorrelations between mother and teacher reported ODD symptom counts from 3rd to 6th grade. Overall, ODD symptom levels between 3rd grade and 6th grade, regardless of reporter, are significantly correlated; however, the strength of the correlations ranged from low to moderate. Mother reported ODD symptom counts were moderately stable across time points (r =.47 to r = .65, $p \leq .01$), whereas teacher reported ODD symptoms were only modestly stable over time. This is not surprising, given that different teachers were reporting on child behavior at each assessment (r =.38 to r = .48, $p \leq .01$). Correlations between mother and teacher reported symptoms of ODD at each time point (r =.21 to r = .27, $p \leq .01$) and across time points (r =.09 to r = .27, $p \leq .01$) were generally low, but significant.

Table 5. Intercorrelations among mother and teacher reported symptom counts of ODD

	1	2	3	4	5	6	7	8
1. ODD Sx – Mother Report, GR 3	--	.57*	.56*	.47*	.21*	.21*	.13*	.19*
2. ODD Sx – Mother Report, GR4		--	.65*	.61*	.14*	.24*	.19*	.16*
3. ODD Sx – Mother Report, GR 5			--	.64*	.14*	.19*	.21*	.27*
4. ODD Sx – Mother Report, GR 6				--	.09*	.18*	.15*	.27*
5. ODD Sx – Teacher Report, GR 3					--	.46*	.42*	.39*
6. ODD Sx – Teacher Report, GR 4						--	.48*	.38*
7. ODD Sx – Teacher Report, GR 5							--	.43*
8. ODD Sx – Teacher Report, GR 6								--

* $p \leq .01$.

The correlations among the predictor variables are presented in Table 6. Higher levels of maternal sensitivity were modestly and significantly associated with lower levels of harsh maternal control at 54 months (r = -.38, $p \leq .01$). Measures of child executive function were also significantly, although modestly, correlated in the expected directions (r = -.31 to r = .24, $p \leq .01$). In addition, low to modest associations were found between parenting variables and executive function variables (r = -.24 to r = .34, $p \leq .01$). Intercorrelations among the outcome variables at 6th grade are presented in Table 7. Academic performance at 6th grade is not significantly correlated with self-reported friendship quality; however, it is significantly associated with social skills as rated by teachers and mothers (r = .51, $p \leq .01$). The association between self-reported friendship quality and teacher/mother reported social skills was low (r = .12, $p \leq .01$), but significant.

Table 6. Intercorrelations among predictor variables

	1	2	3	4	5	6
1. Mean Maternal Sensitivity, 6-54 mos	--	-.38*	-.24*	-.24*	.34*	.17*
2. Harsh Maternal Control, 54 mos		--	.09*	.15*	-.23*	-.10*
3. CPT Omission Errors, 54 mos			--	.24*	-.23*	-.22*
4. CPT Commission Errors, 54 mos				--	-.31*	-.20*
5. Delay of Gratification, 54 mos					--	.14*
6. Tower of Hanoi, GR 1						--

* $p \leq .01$.

Table 7. Intercorrelations among outcome variables

	1	2	3
1. Academic Performance, GR 6	--	.02	.51*
2. Friendship Quality, GR 6		--	.12*
3. Social Skills[a], GR 6			--

[a] Mean of mother and teacher reported social skills total score
* $p \leq .01$.

6.2 HYPOTHESIS 1A: TRAJECTORIES OF ADHD SYMPTOMS IN ELEMENTARY SCHOOL (3RD TO 6TH GRADE)

The trajectory analyses were run using a composite ADHD symptom count score, obtained by averaging the sum of teacher and mother reported HI and IA symptom counts at each grade from 3rd to 6th. Participants were included in the analyses if they had ADHD composite scores at two or more of the four time points. Trajectories were estimated using the censored normal model (CNORM). The CNORM model is recommended for use with a censored variable, such as a psychometric scale in which data cluster at the scale minimum or maximum (Nagin, 2005). Because this is a community sample, we expected a particularly large clustering of scores at the scale minimum thereby indicating an absence of clinical ADHD symptoms. Furthermore, before TRAJ analyses were initiated using the CNORM model, distribution analyses were completed confirming that the data were indeed skewed as expected. Based on previous research, we hypothesized that at least three trajectory groups would be identified. Therefore, three, four, five, and six group models were tested. As discussed above, the final model was determined using the following three criteria: 1) the statistical significance of the polynomial function parameter estimate; 2) maximum Bayesian Information Criterion (BIC); and 3) mean posterior probabilities of group membership greater than or equal to .70.

The statistical significance of the polynomial function parameter estimate was used to determine the optimal shape of each group's trajectory. Models were first run with cubic

coefficient estimates of time to allow for possible nonlinear growth in each trajectory. If a trajectory did not reach significance on the cubic coefficient estimate, estimates were changed to the next order coefficient (i.e. quadratic, linear, and intercept) until all the parameter coefficients were statistically significant. The resulting three, four, five, and six group models were then compared on their BIC scores and their mean estimates of posterior probabilities of group membership (see Table 8). The BIC scores improved as the number of trajectory groups in the models increased. Although, the six group model of ADHD symptoms had the highest BIC score (-8305.14), it was only marginally higher than the five group model BIC score (-8310.53). Furthermore, the mean posterior probabilities of group membership were above .70 for both models but were slightly higher for the five group model. Consequently, in the interest of parsimony, the five group model was selected as the final ADHD symptom model. Parameter estimates employing start values for this model revealed one cubic group, two linear groups, and two groups defined by the intercept (i.e. no change).

Table 8. Model selection criteria and parameters by model type for ADHD trajectory analyses

Model	BIC (N = 4212)	BIC (N = 1081)	ΔBIC	Trajectory Group	Parameters	Mean Posterior Probabilities	Observed N
Three Group	-8417.41	-8409.25		Group 1	3	0.91	517
				Group 2	3	0.88	431
				Group 3	0	0.93	133
Four Group	-8338.07	-8328.55	158.14 / 161.4	Group 1	3	0.88	426
				Group 2	3	0.86	455
				Group 3	0	0.89	158
				Group 4	0	0.94	42
Five Group	-8310.53	-8300.33	55.08 / 56.44	Group 1	3	0.88	410
				Group 2	0	0.86	446
				Group 3	1	0.77	63
				Group 4	1	0.79	116
				Group 5	0	0.93	46
Six Group	-8305.14	-8290.18	10.78 / 20.3	Group 1	3	0.88	379
				Group 2	0	0.85	449
				Group 3	3	0.79	70
				Group 4	1	0.77	97
				Group 5	2	0.81	55
				Group 6	1	0.89	31

Figure 1 displays the five group model of observed and predicted trajectories of ADHD symptoms. The first trajectory includes 37.3% of study children who were rated by their mothers and teachers as exhibiting very low levels of ADHD symptoms from 3rd through 6th grade. They will be referred to as the *Very Low* ADHD symptom trajectory. The largest proportion of the sample, 41.6%, exhibited a static trajectory of low levels of ADHD symptoms consistently across time and will be labeled the *Low* group. The third trajectory group containing 6.4% of the sample evidenced low but increasing levels of ADHD symptoms across time and will be designated as the *Low-Increasing* group. Another trajectory group comprised of 10.4% of the sample is characterized by *High-Decreasing* symptom levels of ADHD and will be referred to as such. Finally, a minority of the sample (4.3%) exhibited high levels of ADHD symptoms consistently from 3rd to 6th grade (*High Stable).* The mean numbers of ADHD symptoms for each trajectory group from 3rd to 6th grade are presented in Table 9.

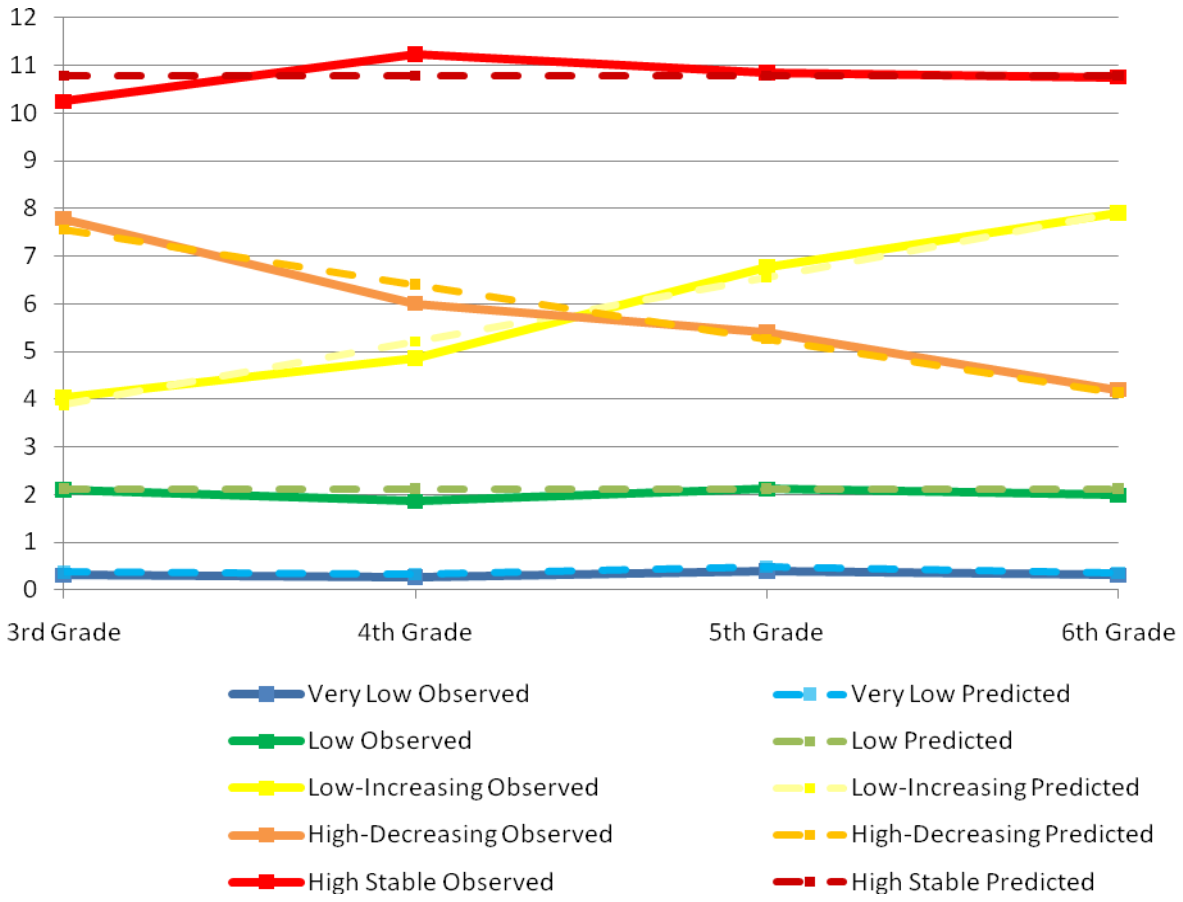

Figure 1. Five Group Trajectory Model of ADHD Symptoms from 3rd through 6th Grade

Table 9. Mean number of ADHD symptoms as a function of ADHD trajectory group from 3rd to 6th grade

	ADHD Symptom Trajectories									
	Very Low (*N* = 410)		*Low* (*N* = 446)		*Low-Increasing* (*N* = 63)		*High-Decreasing* (*N* = 116)		*High Stable* (*N* = 46)	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
3rd Grade	0.24	(0.50)	2.11	(1.81)	3.76	(1.91)	8.22	(2.58)	10.17	(3.82)
4th Grade	0.20	(0.60)	1.91	(1.91)	4.91	(2.62)	6.04	(3.05)	11.40	(3.05)
5th Grade	0.35	(0.64)	2.21	(1.86)	6.73	(2.83)	5.39	(3.03)	10.93	(3.26)
6th Grade	0.26	(0.61)	2.08	(1.82)	8.38	(2.68)	4.07	(2.62)	10.88	(3.58)

6.2.1 Sociodemographic and family context correlates of ADHD symptom trajectory groups

ADHD symptom trajectories were compared on maternal education, income-to-needs, child sex, child ethnicity, and marital status. Separate one-way analyses of variance were used to examine the continuous variables (maternal education and income-to-needs); main effects are reported first followed by pairwise comparisons. Child sex, child ethnicity, and marital status the categorical variables, were investigated using chi-square tests. All of the results are presented in Table 10.

Table 10. Demographic variables by ADHD symptom trajectories

	ADHD Symptom Trajectories									
	Very Low (*N* = 410)		*Low* (*N* = 446)		*Low-Increasing* (*N* = 63)		*High-Decreasing* (*N* = 116)		*High Stable* (*N* = 46)	
	M	*(SD)* or %	*M*	*(SD)* or %	*M*	*(SD)* or %	*M*	*(SD)* or %	*M*	*(SD)* or %
Maternal Education	15.00[a]	(2.32)	14.40[b]	(2.49)	14.46[abc]	(2.46)	13.16[d]	(2.14)	12.76[d]	(1.86)
Income-to-Needs	4.38[a]	(3.03)	3.56[b]	(2.60)	3.06[bc]	(2.25)	2.64[c]	(2.84)	2.24[c]	(1.81)
Child Sex % Male		39		50		76		65		76
Child Ethnicity % Minority		13		17		22		39		30
Marital Status % Stably Married		75		65		48		39		37

Note. Means with different superscripts are significantly different based on Bonferroni post-hoc comparisons at $p < 0.01$.

Each of the demographic variables differed significantly across the ADHD symptom trajectories. Significant main effects were found for maternal education (F (4, 1076) = 20.20, $p < .001$) and income-to-needs (F (4, 1069) = 14.80, $p < .001$). Pairwise comparisons revealed that children in the *Very Low* ADHD symptom trajectory group, on average, had more highly educated mothers than children in the *Low*, *High-Decreasing*, and *High Stable* groups. Mothers of children in the *Low* ADHD symptom trajectory also had more years of education than mothers of children in the *High-Decreasing* and *High Stable* symptom groups. The *Low-Increasing* ADHD trajectory group displayed a significantly higher level of maternal education than either the *High-Decreasing* or the *High Stable* ADHD groups. Finally, the *High-Decreasing* and *High Stable* trajectory groups differed significantly from all of the other ADHD trajectories except each other. Overall, mean level of maternal education decreased in a step-wise pattern as would be expected across the ADHD trajectories except in the case of the *Low-Increasing* trajectory which did not differ from the *Very Low* or *Low* symptom trajectory groups.

As would be expected average income-to-needs also decreased in a step-wise pattern from the *Very Low* ADHD symptom trajectory to the *High Stable* symptom group. The *Very Low* ADHD symptom group had a significantly higher mean income-to-needs ratio than all of the other symptom trajectories. The *Low* ADHD symptom trajectory was found to have a significantly higher mean income-to-needs level than the *High-Decreasing* and *High Stable* symptom trajectories. In contrast, the mean income-to-needs of the *Low-Increasing* ADHD group only differed significantly from that of the *Very Low* group. Finally, the mean income-to-needs ratio of children in the *High-Decreasing* and *High Stable* groups was significantly below that of the two lowest symptom groups: the *Very Low* and *Low* ADHD trajectories.

Child sex (χ^2 (4, N = 1081) = 59.54, p < .001), child ethnicity (χ^2 (4, N = 1081) = 45.71, p < .001) and marital status (χ^2 (4, N = 1080) = 75.84, p < .001) also differed significantly across ADHD symptom trajectories. Whereas the majority of children in the *Very Low* trajectory group were girls, boys and girls were distributed fairly evenly in the *Low* symptom trajectory. However, as might be expected, boys made up the majority of the three elevated symptom trajectory groups: *Low-Increasing*, *High-Decreasing*, and *High Stable*. All of the trajectory groups contained a majority of Caucasian children; however, the percentage of minority children increased across the trajectory groups as the level of ADHD symptoms rose. The only exception to this step-wise increase occurred between the *High-Decreasing* and the *High Stable* trajectory groups: the *High Decreasing* symptom group included a higher percentage of minority children than the *High Stable* group. The number of stably married mothers, mothers who remained married between the study child's 1st and 54th month of life, were highest in the trajectories averaging the lowest number of ADHD symptoms across middle childhood: 75% and 65% of mothers of children in the *Very Low* and *Low* trajectory groups respectively. The proportion of reported marital stability fell as children exhibited higher rates of ADHD symptoms: 48% in the *Low-Increasing* group, 39% in the *High-Decreasing* trajectory, and 37% in the *High Stable* symptom group.

6.3 HYPOTHESIS 1B: TRAJECTORIES OF ODD SYMPTOMS IN ELEMENTARY SCHOOL (3RD TO 6TH GRADE)

Using the mean of mother and teacher reported levels of ODD symptoms from 3rd to 6th grade, trajectory analyses were run and model selection was conducted as described above. We hypothesized that four distinct patterns of ODD symptoms would be found; however, as the

literature to date has reported anywhere from three to six distinct trajectory groups we began by testing a more conservative two group model and went on to run three, four, and five group models.

Table 11 presents a comparison of the BIC scores and mean posterior probabilities for each model. Although the four and five group models obtained the largest BIC scores, their mean posterior probability scores fell below .70 thereby excluding them from consideration. Furthermore, upon closer examination it became clear that the additional groups in the four and five group models resulted from dividing the lower trajectory groups in the three group model into smaller groups which exhibited similar low levels of ODD symptoms, but did not illuminate novel patterns of symptom levels. In addition, the five group model did not provide improved BIC scores when compared to the four group model and was unable to produce posterior probability scores for its third group. Therefore, the three group model was selected as the final trajectory model of ODD symptoms as it met the selection criteria and presented the most meaningful combination of ODD symptom trajectories.

Table 11. Model selection criteria and parameters by model type for ODD trajectory models

Model	BIC (N = 4212)	BIC (N = 1081)	ΔBIC	Trajectory Groups	Parameters	Mean Posterior Probabilities	Observed N
Two Group	-4432.46	-4429.06		Group 1	1	0.96	806
				Group 2	0	0.91	275
Three Group	-4373.41	-4366.61	-59.05 / -62.45	Group 1	1	0.93	742
				Group 2	3	0.89	296
				Group 3	0	0.90	43
Four Group	-4359.72	-4353.60	-13.69 / -13.01	Group 1	0	0.62	423
				Group 2	1	0.88	395
				Group 3	0	0.87	229
				Group 4	0	0.91	34
Five Group	-4368.08	-4361.28	8.36 / 7.68	Group 1	0	0.48	353
				Group 2	0	0.62	440
				Group 3	0	-	-
				Group 4	0	0.82	256
				Group 5	0	0.91	34

As presented in Figure 2, the first trajectory was comprised of the majority of the sample (66.7%) who consistently demonstrated very low levels of ODD symptoms from 3rd to 6th grade and will be referred to as the *Very Low* group. The second trajectory group, constituting 29.2% of the sample, demonstrated low stable levels of ODD symptoms across time and will be labeled the *Low* group. Finally, a small minority (4.1%) were rated high on ODD symptoms at each time point and will be designated the *High* group. Mean symptom levels for each trajectory group at each time point may be found in Table 12.

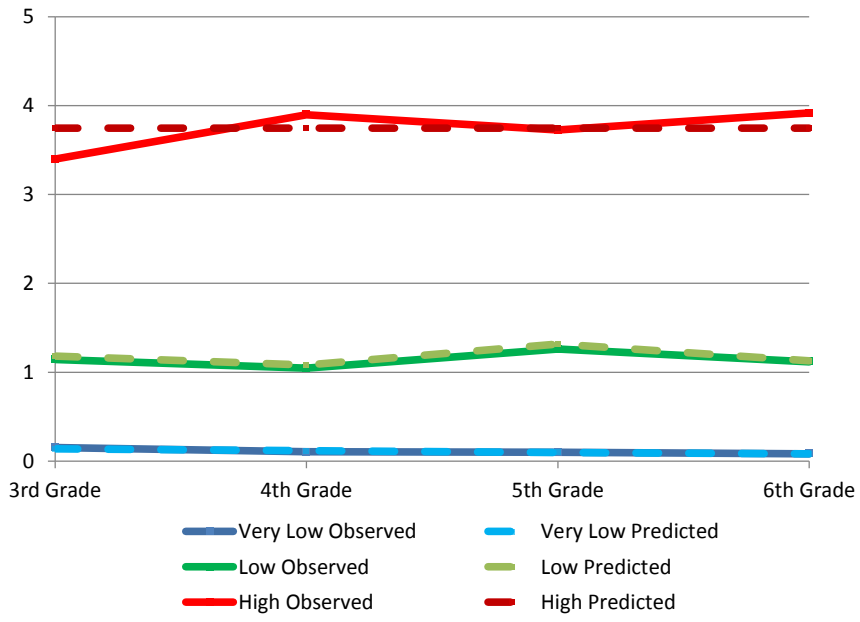

Figure 2. Three group trajectory model of ODD symptoms from 3rd through 6th grade

Table 12. Mean number of ODD symptoms as a function of ODD trajectory group from 3rd to 6th grade

	ODD Symptom Trajectories					
	Very Low (*N* = 742)		*Low* (*N* = 296)		*High* (*N* = 43)	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
3rd Grade	0.15	(0.43)	1.21	(1.24)	3.51	(2.06)
4th Grade	0.10	(0.31)	1.12	(1.14)	4.01	(2.25)
5th Grade	0.09	(0.27)	1.36	(1.18)	3.82	(1.86)
6th Grade	0.08	(0.27)	1.20	(1.24)	4.04	(2.02)

6.3.1 Sociodemographic and family context correlates of ODD symptom trajectory groups

Maternal education, income-to-needs, child sex, child ethnicity, and marital status were all examined separately as a function of ODD trajectory groups using the statistical procedures outlined above. Significant main effects were found for all of the variables; results are summarized in Table 13.

Table 13. Demographic variables by ODD symptom trajectories

	ODD Symptom Trajectories					
	Very Low (*N* = 742)		*Low* (*N* = 296)		*High* (*N* = 43)	
	M	(*SD*) or %	*M*	(*SD*) or %	*M*	(*SD*) or %
Maternal Education	14.68[a]	(2.39)	14.07[b]	(2.51)	12.67[c]	(1.96)
Income-to-Needs	3.97[a]	(2.76)	3.21[b]	(2.97)	2.05[c]	(1.88)
Child Sex % Male		47		57		61
Child Ethnicity % Minority		15		25		33
Marital Status % Stably Married		70		55		30

Note. Means with different superscripts are significantly different based on Bonferroni post-hoc comparisons at $p < 0.05$.

One-way ANOVAs were conducted examining the association between ODD trajectories and the continuous demographic variables: maternal education and income-to-needs. Both maternal education (F (2, 1078) = 18.68, $p < .001$) and income-to-needs (F (2, 1071) = 15.24, $p < .001$) were significantly different across ODD symptom trajectories. Level of maternal education and income were significantly higher in the *Very Low* ODD group than in the *Low* and the *High* groups, and they also decreased significantly between the *Low* and *High* symptom groups, as average ODD symptom levels increased.

Chi-square tests revealed significant differences between ODD symptom trajectory groups in child sex (χ^2 (2, N = 1081) = 11.51, $p < .01$), ethnicity (χ^2 (2, N = 1081) = 19.12, $p < .001$), and marital status (χ^2 (2, N = 1080) = 41.99, $p < .001$); all of the differences were in the expected direction. Males constituted a minority (47%) in the *Very Low* ODD symptom group but formed a steadily increasing majority in the trajectory groups exhibiting higher levels of ODD symptoms: 57% of the *Low* group, and 61% of the *High* ODD trajectory group. Conversely, the proportion of mothers reporting stable marital status was highest in the trajectory group exhibiting the lowest level of ODD symptoms and decreased as mean level of ODD symptoms increased: 70% in the *Very Low* group, 55% in the *Low* group, and 30% in the *High* ODD trajectory group. Finally, the percentage of minority children increased in a step-wise manner across ODD trajectory group: 15% minority children in the *Very Low* group, 25% minority children in the *Low* group, and 33% minority children in the *High* ODD symptom trajectory.

6.4 HYPOTHESIS 1C: DUAL TRAJECTORIES OF ADHD AND ODD SYMPTOMS IN ELEMENTARY SCHOOL (3RD TO 6TH GRADE)

As outlined above, a dual trajectory model was then run using the parameter estimates of the previously defined best-fit ADHD symptom model and best-fit ODD symptom model in order to calculate a dual trajectory model of ADHD and ODD symptoms. In addition to coefficient estimates of the trajectory shapes and probability of trajectory group membership, output which is also produced by the univariate trajectory models, the dual trajectory model provides three key estimations of the probabilities linking the two variables of interest: 1) the probability of membership in each of the ADHD trajectory groups conditional upon membership in each of the ODD trajectory groups; 2) the probability of membership in each of the ODD trajectory groups as a function of membership in each of the ADHD trajectory groups; and 3) the joint probability of membership in a specific ADHD symptom trajectory and a specific ODD symptom trajectory – joint probabilities of membership are calculated for all the possible combination of ADHD and ODD trajectory groups. Unfortunately, 11 out of the 15 possible combinations of the ADHD and ODD trajectory groups in the current analyses included fewer than 50 participants. Due to these very small cell sizes ranging from 0 to 41, the dual trajectory model was unable to calculate standard errors or joint probabilities. Consequently, we were unable to use the TRAJ dual trajectory model to examine the longitudinal association between the univariate trajectories of ADHD and ODD symptoms. Because TRAJ was unable to produce a dual trajectory model with the data, the hypotheses were tested using another statistical procedure: cross-classification analysis.

As outlined by Nagin (2005), cross-classification analysis is an alternative approach to the dual trajectory model. Cross classification analysis is conducted by: 1) sorting the sample

members into the trajectory groups identified by the two univariate symptom trajectory models on the basis of posterior probabilities of group membership; and 2) cross-tabulating the group membership counts. Although this procedure has some significant disadvantages compared to dual trajectory analysis (Nagin, 2005), for example estimates from cross-classification analyses tend to be less exact than those provided by the dual trajectory model, we determined that, keeping these disadvantages in mind when interpreting the results from the analyses, there was more value in examining the initial question using these statistical means than abandoning the investigation entirely. Therefore, the cross-classification analysis was conducted as outlined above resulting in a matrices depicting estimates of group membership in each combination of the univariate trajectories (see Table 14) e.g. *Very Low* ADHD symptoms * *Very Low* ODD symptoms etc.

Table 14. Cross-classification of participants from ADHD and ODD symptom trajectories

ADHD Univariate Trajectories	ODD Univariate Trajectories		
	Very Low (*N* = 742)	Low (*N* = 296)	High (*N* = 43)
Very Low (*N* = 410)	390 (95)* (53)**	20 (5) (7)	0 (0) (0)
Low (*N* = 446)	301 (68) (40.5)	140 (31) (47)	5 (1) (12)
Low-Increasing (*N* = 63)	15 (24) (2)	41 (65) (14)	7 (11) (16)
High-Decreasing (*N* = 116)	32 (28) (4)	73 (63) (25)	11 (9) (26)
High-Stable (*N* = 46)	4 (9) (0.5)	22 (48) (7)	20 (43) (46)

* Percentage of ADHD Trajectory group classified in ODD Trajectory group.

** Percentage of ODD Trajectory group classified in ADHD Trajectory group.

As illustrated in Table 14, the cross-classification analyses revealed that the overwhelming majority of the members (95%; *n* = 390 out of 410) in the *Very Low* ADHD symptom trajectory were also members in the *Very Low* ODD symptom trajectory. The remaining 5% of the members (*n* = 20) in the *Very Low* ADHD symptom group fell into the *Low* ODD symptom trajectory; there was no overlap found between membership in the *Very Low* ADHD trajectory and membership in the *High* ODD trajectory group. A similar pattern was found for the *Low* ADHD symptom trajectory in which the majority of participants (68%; *n* = 301 out of 446) were cross-classified into the *Very Low* ODD symptom group. A sizeable number (31%; *n* = 140) of participants demonstrating *Low* levels of ADHD symptoms across middle childhood also showed *Low* levels of ODD symptoms across this time period. Finally, only about 1% (*n* = 5) of the members of the *Low* ADHD symptom trajectory demonstrated comorbid *High* levels of ODD symptoms. The majority of the participants (65%; *n* = 41 out of 63) in the *Low-Increasing* ADHD symptom trajectory were classified with *Low* levels of comorbid ODD symptoms compared to *Very Low* levels of ODD symptoms (24%; *n* = 15). Eleven percent (*n* = 7) of the members of the *Low-Increasing* ADHD symptom trajectory demonstrated *High* levels of comorbid ODD symptoms.

Members of the *High-Decreasing* ADHD symptom trajectory were distributed in a similar manner across the ODD symptom trajectories. Approximately 28% of the members (*n* = 32) demonstrated *Very Low* levels of comorbid ODD symptoms, whereas the majority, 63% (*n* = 73), were cross-classified into the *Low* ODD symptom group, and the remaining 9% (*n* = 11) were rated, on average, by mothers and teachers as showing *High* levels of comorbid ODD symptoms across middle childhood. Finally, as would be expected, a large portion of the

participants (45%; *n* = 20 out of 46) who demonstrated *High Stable* levels of ADHD symptoms were found to be in the *High* ODD symptom trajectory. Out of the remaining 26 members in the *High Stable* ADHD symptom trajectory, 22 (48%) of them were classified in the *Low* ODD symptom trajectory and only 4 (9%) were found to demonstrate *Very Low* comorbid symptoms of ODD.

Examining the cross-classification analyses as a function of the ODD symptom trajectory groups we found the following results. Members in the *Very Low* ODD symptom trajectory group were generally cross-classified into either the *Very Low* (53%; *n* = 390 out of 742) or the *Low* (40.5%; *n* = 301) ADHD symptom groups. Two percent (*n* = 15), 4% (*n* = 32), and 0.5% (*n* = 4) fell into the *Low-Increasing*, *High-Decreasing*, and *High Stable* ADHD symptom trajectories respectively. Interestingly, the pattern of distribution was somewhat different for the *Low* ODD symptom group. Although the majority (47%; *n* = 140 out of 296) of the *Low* ODD members were cross-classified in the *Low* ADHD symptom group, only 20 (7%) of members fell into the *Very Low* ADHD symptom group. The second largest portion of members (25%; *n* = 73) was found in the *High-Decreasing* ADHD symptom trajectory. Fourteen percent (*n* = 41) of members fell into the *Low-Increasing* ADHD symptom trajectory and the final 7% (*n* = 22) were categorized as displaying *High Stable* levels of ADHD symptoms across middle childhood. Finally, as would be expected, members in the *High* ODD symptom trajectory were distributed in a step-wise pattern across the ADHD symptom groups with the majority of members (46%; *n* = 20 out of 43) falling into the *High Stable* ADHD symptom group. The remaining 53% of members were cross-classified into the *High-Decreasing* (26%; *n* = 11), *Low-Increasing* (16%; *n* = 7), and *Low* (12%; *n* = 5) ADHD groups with none of the members falling into the *Very Low* ADHD symptom trajectory.

6.5 HYPOTHESIS 2A: EARLY CHILD AND PARENTING FACTORS WILL PREDICT LATER ADHD AND ODD MEMBERSHIP DIFFERENTIALLY

A series of multinomial logistic regressions were conducted to determine how well earlier measures of executive function, maternal sensitivity, and harsh maternal control predicted membership in the univariate ADHD symptom trajectory groups and the ODD symptom trajectory groups. In order to test the a priori hypotheses regarding the predictive relation between the earlier child and parenting factors and ADHD and ODD symptoms specifically, the analyses were run twice for each set of symptom trajectories. The first series of analyses, Model I, examined the predictive relation between early child and parenting factors and later ADHD or ODD symptoms trajectory membership controlling only for maternal education and child sex. In contrast, the second series of analyses, Model II, attempted to remove the potential confound of comorbid symptoms by including a measure of concurrent ADHD or ODD symptoms as a control variable. The results reported below are from the Model II analyses which included the control variables for comorbid symptoms of ADHD or ODD. Results from Model I, the analyses that did not control for comorbid symptoms of ADHD or ODD, are only reported when they contrast significantly with results from Model II or when they pertain to the hypotheses.

Because there were more than two trajectory groups in both the ADHD and ODD models, several multinomial logistic regressions were run for each predictor in order to compare all of the trajectory groups with one another. For example, in the first set of analyses the *Very Low* ADHD symptom group was used as the reference group, in the second set of analyses the *Low* ADHD symptom trajectory group was employed as the reference group, and so on until each trajectory group comparison was captured. The same procedure was used for the analyses examining the association between potential earlier predictors and ODD symptom groups.

Finally, all continuous variables were centered prior to analysis in order to avoid multicollinearity.

6.5.1 Predictors of ADHD symptom trajectories

6.5.1.1 Child factors: Early measures of executive function

All of the overall models examining executive functioning as a predictor of ADHD symptoms trajectories were significant. The results from the statistically significant pairwise comparisons are presented below; all of the results from Model I and II are presented in Tables 16 – 17 and unadjusted predictor means as a function of symptom trajectory may be found in Table 15.

Table 15. Unadjusted means for predictor variables as a function of ADHD and ODD trajectory groups

Trajectory Groups	Executive Function Measures				Parenting Measures	
	CPT Errors of Commission	CPT Errors of Omission	Delay of Gratification	Tower of Hanoi	Maternal Sensitivity (Mean z-score)	Harsh Parenting
ADHD Symptoms						
Very Low	8.58	7.93	5.09	15.62	0.22	20.45
Low	14.51	9.06	4.61	14.24	0.06	21.28
Low-Increasing	21.66	9.41	4.10	13.91	-0.13	21.45
High-Decreasing	22.58	11.68	2.72	12.42	-0.54	22.48
High Stable	25.88	11.67	3.03	9.76	-0.50	22.87
ODD Symptoms						
Very Low	12.50	8.44	4.77	14.60	0.12	20.81
Low	16.53	9.98	4.04	14.01	-0.12	21.82
High	20.83	12.93	2.83	13.06	-0.71	22.71

Table 16. Multinomial logistic regressions predicting trajectories of ADHD symptoms in middle childhood from Continuous Performance Test at 54 months controlling for maternal education, child sex (Model I), and concurrent symptoms of ODD (Model II) (Imputed Data Set)

	Model I				Model II			
	B	*SE*	Wald	OR	*B*	*SE*	Wald	OR
CPT: Errors of Omission								
Very Low vs.								
Low	0.020	0.010	3.562	1.020	0.010	0.011	0.716	1.010
Low-Increasing	0.028	0.019	2.025	1.028	0.004	0.022	0.039	1.004
High-Decreasing	0.054	0.015	13.489	**1.055****	0.034	0.017	4.130	**1.035***
High Stable	0.047	0.021	5.017	**1.048***	0.014	0.027	0.265	1.014
Low vs.								
Low-Increasing	0.008	0.019	0.178	1.008	-0.005	0.020	0.064	0.995
High-Decreasing	0.034	0.014	6.168	**1.035***	0.025	0.015	2.796	1.025
High Stable	0.027	0.020	1.815	1.028	0.004	0.026	0.029	1.004
Low-Increasing vs.								
High-Decreasing	0.026	0.021	1.533	1.026	0.030	0.022	1.843	1.030
High Stable	0.019	0.026	0.567	1.020	0.010	0.029	0.108	1.010
High-Decreasing vs.								
High Stable	-0.007	0.022	0.092	0.993	-0.020	0.026	0.623	0.980
CPT: Errors of Commission								
Very Low vs.								
Low	0.022	0.005	16.428	**1.022****	0.016	0.005	9.059	**1.016****
Low-Increasing	0.032	0.007	21.114	**1.032****	0.028	0.007	14.205	**1.028****
High-Decreasing	0.032	0.006	26.625	**1.032****	0.026	0.006	16.332	**1.026****
High Stable	0.033	0.007	21.622	**1.034****	0.032	0.008	15.148	**1.033****
Low vs.								
Low-Increasing	0.010	0.006	3.480	1.010	0.012	0.006	4.065	**1.012***
High-Decreasing	0.010	0.004	5.089	**1.010***	0.010	0.005	4.770	**1.010***
High Stable	0.012	0.006	4.217	**1.012***	0.017	0.007	5.656	**1.017***
Low-Increasing vs.								
High-Decreasing	0.000	0.006	0.002	1.000	-0.002	0.006	0.060	0.998
High Stable	0.002	0.007	0.052	1.002	0.005	0.008	0.380	1.005
High-Decreasing vs.								
High Stable	0.002	0.006	0.096	1.002	0.006	0.007	0.842	1.006

* $p < .05$, ** $p < .005$.

Table 17. Multinomial logistic regressions predicting trajectories of ADHD symptoms in middle childhood from Delay of Gratification Task and the Tower of Hanoi Task controlling for maternal education, child sex (Model I), and concurrent symptoms of ODD (Model II) (Imputed Data Set)

	Model I				Model II			
	B	*SE*	Wald	OR	*B*	*SE*	Wald	OR
Delay of Gratification (54 mos)								
Very Low vs.								
Low	-0.061	0.026	5.264	**0.941***	-0.041	0.029	2.097	0.960
Low-Increasing	-0.137	0.050	7.359	**0.872***	-0.087	0.057	2.325	0.917
High-Decreasing	-0.250	0.041	37.535	**0.779****	-0.196	0.046	17.811	**0.822****
High Stable	-0.244	0.060	14.164	**0.799****	-0.151	0.074	4.177	**0.859***
Low vs.								
Low-Increasing	-0.076	0.049	2.391	0.927	-0.046	0.054	0.727	0.955
High-Decreasing	-0.190	0.039	23.365	**0.827****	-0.154	0.042	13.443	**0.857****
High Stable	-0.163	0.058	7.862	**0.849****	-0.110	0.071	2.410	0.896
Low-Increasing vs.								
High-Decreasing	-0.114	0.058	3.898	**0.893***	-0.109	0.060	3.267	0.897
High Stable	-0.087	0.072	1.481	0.917	-0.064	0.079	0.666	0.938
High-Decreasing vs.								
High Stable	0.026	0.065	0.166	1.027	0.044	0.073	0.363	1.045
Tower of Hanoi (1st Grade)								
Very Low vs.								
Low	-0.027	0.011	6.215	**0.973***	-0.036	0.012	8.619	**0.965****
Low-Increasing	-0.031	0.022	1.939	0.969	-0.054	0.025	4.697	**0.947***
High-Decreasing	-0.073	0.019	15.230	**0.930****	-0.094	0.021	19.380	**0.910****
High Stable	-0.137	0.031	19.884	**0.872****	-0.188	0.038	24.529	**0.828****
Low vs.								
Low-Increasing	-0.004	0.022	0.030	0.996	-0.018	0.023	0.597	0.982
High-Decreasing	-0.046	0.018	6.245	**0.955***	-0.058	0.019	8.958	**0.944****
High Stable	-0.109	0.030	13.047	**0.897****	-0.152	0.037	17.145	**0.859****
Low-Increasing vs.								
High-Decreasing	-0.042	0.027	2.484	0.959	-0.040	0.026	2.255	0.961
High Stable	-0.105	0.036	8.702	**0.900****	-0.134	0.040	11.452	**0.874****
High-Decreasing vs.								
High Stable	-0.064	0.033	3.772	0.938	-0.095	0.037	6.578	**0.910***

* $p < .05$, ** $p < .005$.

Continuous Performance Test at 54 months: Errors of commission and omission. The overall models including 54 month errors of commission and omission as predictors were significant (Likelihood ratio χ^2 (16) = 643.118, p<.001, and 624.102, p<.001, respectively), with ODD symptoms controlled. More errors of commission predicted group membership in the *Low*, *Low- Increasing*, *High-Decreasing*, and *High Stable* ADHD symptom trajectory groups compared to the *Very Low* group. Similarly, higher levels of commission errors predicted membership in the *Low- Increasing*, *High-Decreasing*, and *High Stable* ADHD trajectories relative to the *Low* trajectory. In contrast, a higher number of errors of omission at 54 months predicted a greater probability of group membership only in the *High-Decreasing* ADHD trajectory compared to the *Very Low* trajectory.

In the analyses excluding the control for concurrent symptoms of ODD (Model I: Table 16), similar results were obtained for errors of commission. However, two additional significant associations were found for errors of omission: greater difficulty paying attention, as operationalized by more errors of omission, increased the probability of later group membership in the *High Stable* compared to the *Very Low* trajectory group and the *High Decreasing* versus the *Low* symptom group.

Delay of Gratification at 54 months: Time waited. The ability to delay gratification measured at 54 months was also a significant predictor of membership in later ADHD symptom trajectory groups (Likelihood ratio χ^2 (16) = 638.653, p<.001). More specifically, with ODD symptoms controlled, the longer a child was able to wait at 54 months predicted a higher probability of being in the *Very Low* ADHD symptom group as compared to the *High-Decreasing* or the *High Stable* symptom groups. In addition, the ability to delay gratification at

54 months predicted membership in the *Low* ADHD trajectory group as compared to the *High-Decreasing* trajectory group. Complete results may be found in Table 17.

Additional significant predictive associations were found in the Model I analyses, when concurrent ODD symptoms were not included in the model (see Table 17). Results from these analyses indicate that better ability to delay gratification at 54 months predicted a greater likelihood of later membership in the *Very Low* ADHD symptom group compared to all of the other trajectory groups. Furthermore, the more time a child was able to wait at 54 months, the greater the probability of later membership in the *Very Low* in contrast to the *High Stable* trajectory and the *Low-Increasing* symptom trajectory compared to the *High-Decreasing* ADHD symptom trajectory.

Tower of Hanoi at 1st grade: Measure of planning. Similar to the other measures of executive function, children's planning ability at 1st grade significantly predicted later membership in ADHD symptom groups (Likelihood ratio χ^2 (16) = 657.140, p<.001), over and above ODD symptoms. Better planning skills, represented by higher scores, predicted a higher likelihood of later membership in the *Very Low* ADHD symptom group compared to the *Low, Low-Increasing, High-Decreasing,* and *High Stable* symptom groups. Superior planning also predicted later group membership in the *Low* ADHD symptom group compared to the *High-Decreasing* and *High Stable* ADHD groups. In addition, better planning performance at 1st grade increased the probability of later membership in the *Low-Increasing* and *High-Decreasing* trajectories in contrast to the *High Stable* ADHD symptom trajectory. Results of the analyses from Model I were similar and are presented in Table 17.

6.5.1.2 Parenting factors: Mean maternal sensitivity from 6 to 54 months and harsh maternal control at 54 months

Both models examining maternal sensitivity (Model II: Likelihood ratio χ^2 (16) = 642.394, $p < .001$; Model I: Likelihood ratio χ^2 (12) = 200.185, $p < .001$) and harsh maternal control (Model II: Likelihood ratio χ^2 (16) = 625.259, $p < .001$; Model I: Likelihood ratio χ^2 (12) = 172.972, $p < .001$) as predictors of later ADHD symptom trajectories were significant (see Table 18). Higher levels of maternal sensitivity from 6 to 54 months predicted a greater probability of later membership in the *Very Low* ADHD symptom group compared to the *Low-Increasing* or the *High-Decreasing* symptom groups. Similarly, higher levels of early maternal sensitivity also predicted increased probability of membership in the *Very Low* ADHD symptom group as compared to the *High Decreasing* group. Finally, higher levels of harsh maternal parenting predicted a higher probability of membership in the *High Decreasing* ADHD trajectory group compared to the *Very Low* ADHD group. As would be expected, both parenting factors were more predictive of later ADHD symptom trajectory membership when the measure of concurrent ODD symptoms was not included as a control variable in the analyses (see Table 18).

Table 18. Multinomial logistic regressions predicting trajectories of ADHD symptoms in middle childhood from parenting measures controlling for maternal education, child sex (Model I), and concurrent symptoms of ODD (Model II) (Imputed Data Set)

	Model I				Model II			
	B	*SE*	Wald	OR	*B*	*SE*	Wald	OR
Mean Maternal Sensitivity (6-54 mos)								
Very Low vs.								
Low	-0.295	0.123	5.773	**0.745***	-0.114	0.132	0.743	0.892
Low-Increasing	-0.841	0.220	14.582	**0.431****	-0.492	0.245	4.035	**0.612***
High-Decreasing	-1.167	0.171	46.601	**0.311****	-0.856	0.193	19.558	**0.425****
High Stable	-1.008	0.236	18.251	**0.365****	-0.489	0.291	2.827	0.613
Low vs.								
Low-Increasing	-0.546	0.212	6.633	**0.579***	-0.378	0.226	2.799	0.685
High-Decreasing	-0.872	0.158	30.403	**0.418****	-0.742	0.170	19.120	**0.476****
High Stable	-0.713	0.277	9.911	**0.490****	-0.375	0.273	1.890	0.687
Low-Increasing vs.								
High-Decreasing	-0.326	0.232	1.977	0.722	-0.364	0.236	2.379	0.695
High Stable	-0.167	0.283	0.350	0.846	0.003	0.307	0.000	1.003
High-Decreasing vs.								
High Stable	0.158	0.239	0.441	1.172	0.367	0.268	1.869	1.443
Harsh Maternal Control (54 mos)								
Very Low vs.								
Low	0.070	0.023	8.956	**1.073****	0.041	0.026	2.536	1.041
Low-Increasing	0.113	0.048	5.610	**1.120***	0.034	0.052	0.414	1.034
High-Decreasing	0.167	0.038	19.132	**1.182****	0.089	0.043	4.296	**1.093***
High Stable	0.236	0.057	16.923	**1.266****	0.104	0.069	2.291	1.110
Low vs.								
Low-Increasing	0.043	0.047	0.845	1.044	-0.007	0.049	0.021	0.993
High-Decreasing	0.097	0.037	6.902	**1.102***	0.048	0.039	1.527	1.049
High Stable	0.166	0.056	8.696	**1.181****	0.063	0.066	0.924	1.065
Low-Increasing vs.								
High-Decreasing	0.053	0.055	0.949	1.055	0.055	0.055	0.993	1.057
High Stable	0.123	0.069	3.148	1.130	0.070	0.074	0.908	1.073
High-Decreasing vs.								
High Stable	0.069	0.062	1.258	1.072	0.015	0.067	0.052	1.015

* $p < .05$, ** $p < .005$.

6.5.2 Predictors of ODD symptom trajectories

All of the overall models examining earlier child factors (Errors of Omission: Likelihood ratio χ^2 (8) = 367.911, $p < .001$; Errors of Commission: Likelihood ratio χ^2 (8) = 366.471, $p<.001$; Delay of Gratification: Likelihood ratio χ^2 (8) = 366.365, $p < .001$; and Tower of Hanoi: Likelihood ratio χ^2 (8) = 374.089, $p < .001$) and parenting factors (maternal sensitivity: Likelihood ratio χ^2 (8) = 371.200, $p < .001$; and harsh maternal control: Likelihood ratio χ^2 (8) = 369.455, $p < .001$) as predictors of later ODD symptom trajectories controlling for maternal education, child sex, and comorbid ADHD symptoms were significant. Only the statistically significant predictive associations are presented below; however, all of the results are recorded in Tables 19-21 and predictor means as a function of ODD trajectory group may be found in Table 15.

Table 19. Multinomial logistic regressions predicting trajectories of ODD symptoms in middle childhood from Continuous Performance Test at 54 months controlling for maternal education, child sex (Model I), and concurrent symptoms of ADHD (Model II) (Imputed Data Set)

	Model I				Model II			
	B	*SE*	Wald	OR	*B*	*SE*	Wald	OR
CPT: Errors of Omission								
Very Low vs.								
Low	0.025	0.010	6.348	**1.025***	0.006	0.011	0.290	1.006
High	0.055	0.020	7.885	**1.056****	0.037	0.023	2.595	1.038
High vs.								
Low	-0.030	0.020	2.297	0.970	-0.031	0.022	1.986	0.970
CPT: Errors of Commission								
Very Low vs.								
Low	0.007	0.003	4.494	**1.007***	-0.003	0.004	0.630	0.997
High	0.007	0.007	1.048	1.007	-0.007	0.008	0.771	0.993
High vs.								
Low	0.000	0.007	0.004	1.000	0.004	0.008	0.264	1.004

* $p < .05$, ** $p < .005$.

Table 20. Multinomial logistic regressions predicting trajectories of ODD symptoms in middle childhood from Delay of Gratification Task and Tower of Hanoi Task controlling for maternal education, child sex (Model I), and concurrent symptoms of ADHD (Model II) (Imputed Data Set)

	Model I				Model II			
	B	*SE*	Wald	OR	*B*	*SE*	Wald	OR
Delay of Gratification (54 mos)								
Very Low vs.								
Low	-0.085	0.025	11.268	**0.919****	-0.012	0.030	0.157	0.988
High	-0.186	0.059	9.980	**0.830****	-0.064	0.067	0.935	0.938
High vs.								
Low	0.101	0.061	2.792	1.107	0.053	0.064	0.672	1.054
Tower of Hanoi (1st Grade)								
Very Low vs.								
Low	-0.011	0.011	0.936	0.989	0.031	0.013	5.831	**1.031***
High	-0.012	0.026	0.225	0.988	0.067	0.028	5.579	**1.069***
High vs.								
Low	0.001	0.027	0.003	1.001	-0.036	0.027	1.738	0.965

* $p < .05$, ** $p < .005$.

Table 21. Multinomial logistic regressions predicting trajectories of ODD symptoms in middle childhood from Parenting measures controlling for maternal education, child sex (Model I), and concurrent symptoms of ADHD (Model II) (Imputed Data Set)

	Model I				Model II			
	B	*SE*	Wald	OR	*B*	*SE*	Wald	OR
Mean Maternal Sensitivity (6-54 mos)								
Very Low vs.								
Low	-0.348	0.111	9.858	**0.706****	0.018	0.129	0.020	1.019
High	-1.000	0.210	22.593	**0.368****	-0.535	0.242	4.883	**0.586***
High vs.								
Low	0.652	0.214	9.279	**1.919****	0.553	0.229	5.859	**1.739***
Harsh Maternal Control (54 mos)								
Very Low vs.								
Low	0.094	0.024	15.541	**1.099****	0.044	0.027	2.742	1.045
High	0.168	0.056	9.075	**1.183****	0.098	0.063	2.381	1.103
High vs.								
Low	-0.074	0.057	1.662	0.929	-0.054	0.061	0.758	0.948

* $p < .05$, ** $p < .005$.

6.5.2.1 Child factors: Early measures of executive function

Continuous Performance Test at 54 months: Errors of commission and omission. Neither measure of inattention (errors of omission) nor behavioral inhibition (errors of commission) significantly predicted later group membership in ODD symptom trajectory groups, when concurrent ADHD symptoms were controlled. However, when concurrent symptoms of ADHD were not included in the model (Model I: see Table 19), higher levels of inattention, operationalized by a greater number of errors of omission, significantly predicted a greater likelihood of later membership in the *Very Low* ODD symptom trajectory compared to the *Low* or *High* trajectory groups.

Delay of Gratification at 54 months: Time waited. The ability to delay gratification also did not significantly predict later ODD symptom trajectory groups when concurrent ADHD symptoms were controlled in the model. In contrast, in Model I, the same multinomial logistic analyses run without including concurrent ADHD symptoms as a control variable, better ability to delay gratification at 54 months significantly predicted a greater probability of later group membership in the *Very Low* ODD symptom trajectory compared to the *Low* and *High* ODD groups (see Table 20).

Tower of Hanoi at 1st grade: Measure of planning. In contrast to the other measures of early executive function, planning ability at 1st grade was found to predict later membership in ODD symptom groups: better planning skills, represented by higher scores, predicted later membership in the *Very Low* ODD symptom group compared to the *Low* symptom trajectory. Interestingly, early planning skills were not found to predict later ODD trajectory membership when concurrent ADHD symptoms were not controlled in Model I (see Table 20).

6.5.2.2 Parenting factors: Mean maternal sensitivity from 6 to 54 months and harsh maternal control at 54 months

Higher levels of maternal sensitivity from 6 to 54 months predicted a greater probability of later membership in the *Very Low* ODD symptom trajectory compared to the *High* symptom trajectory. Higher levels of maternal sensitivity also predicted an increased probability of membership in the *Low* ODD symptom group versus the *High* ODD symptom group. In contrast, harsh maternal parenting at 54 months did not predict later group membership in the ODD symptom trajectories.

Further statistically significant associations were found in Model I, when comorbid ADHD symptoms were not included as a covariate (see Table 21). For example, in addition to the findings reported above, higher levels of observed maternal sensitivity from 6 to 54 months predicted later membership in the *Very Low* ODD symptom trajectory compared to the *Low* group. Finally, higher levels of harsh maternal discipline at 54 months predicted later group membership in the *Low* and *High* trajectories compared to the *Very Low* ODD symptom trajectory.

6.6 HYPOTHESIS 2B: EARLY CHILD AND PARENTING FACTORS WILL PREDICT LATER DUAL TRAJECTORY MEMBERSHIP

In order to test the additive hypothesis (i.e., elevations on both ADHD and ODD symptom trajectories will be associated with higher levels of risk factors compared to the dual symptom groups displaying elevated symptoms on only one disorder), we planned to conduct analyses contrasting the *High Stable / Very Low+Low* ADHD/ODD symptom group, which we shall call

the *ADHD only* group, the *Very Low+Low / High* ADHD/ODD (i.e., *ODD only* group), with the *High Stable / High* ADHD/ODD symptom group, which we will label the *Comorbid* group. Because only 5 children were elevated on ODD symptoms in the absence of ADHD symptoms, it was not possible to conduct analyses contrasting the *ODD only* group with the other two groups of interest. It was possible, however, to conduct binary regressions to determine how well earlier measures of executive function, maternal sensitivity, and harsh maternal control predicted membership in the *ADHD only* group in contrast to the *Comorbid* group. Maternal education and child sex were included as control variables but were not significant predictors in any of the analyses. As in all prior analyses, the continuous variables were centered in order to avoid multicollinearity.

6.6.1 Child factors: Early measures of executive function

None of the early executive function tasks differentially predicted membership in the *ADHD only* group in comparison with the *Comorbid* group.

6.6.2 Parenting factors: Mean maternal sensitivity from 6 to 54 months and harsh maternal control at 54 months

Similar to the pattern of results reported above, neither mean maternal sensitivity nor harsh maternal control were found to predict membership differentially in the *ADHD only* or *Comorbid* groups.

6.7 HYPOTHESIS 3A: ACADEMIC AND SOCIAL OUTCOMES AT SIXTH GRADE WILL BE DIFFERENTIALLY ASSOCIATED WITH ADHD AND ODD TRAJECTORY GROUP MEMBERSHIP AFTER CONTROLLING FOR CONCURRENT ODD AND ADHD SYMPTOMS RESPECTIVELY

Analyses of covariance (ANCOVAs) were conducted to examine whether trajectory groups differed in academic performance, self-reported friendship quality, and teacher/parent reported social competence at 6th grade. Maternal education and child sex were entered as control variables in all of the analyses. When ADHD symptom trajectories were the dependent variable, concurrent ODD symptoms (mean from 3rd to 6th grade) were controlled in the analyses; conversely, when ODD symptoms were the dependent variable, concurrent ADHD symptoms (mean from 3rd to 6th grade) were controlled, to adjust for the potential confounding effect of comorbid symptoms. To provide a thorough test of the hypotheses, a second set of ANCOVAs were conducted without the concurrent measure of ODD or ADHD symptoms. Results from the first set of analyses are presented below. Results from the second set, without controls for co-morbid symptoms, will be presented only when they provide new or interesting information. However, a complete summary of results from both sets of analyses may be found in Tables 22 – 25.

Table 22. Sixth grade child outcomes by ADHD symptom trajectories controlling for maternal education, sex, and ODD symptoms (Adjusted Means)

	ADHD Symptom Trajectory Groups										Group Comparisons
	Very Low (*N* = 410) (1)		*Low* (*N* = 446) (2)		*Low-Increasing* (*N* = 63) (3)		*High-Decreasing* (*N* = 116) (4)		*High Stable* (*N* = 46) (5)		
	M	*(SE)*	*M*	*(SE)*	*M*	*(SE)*	*M*	*(SE)*	*M*	*(SE)*	
Social Outcomes											
Mean SSRS	108.55	0.51	103.62	0.44	98.65	1.23	102.17	0.93	101.80	1.62	**1>2,3,4,5**** **2>3****
Friendship Quality	4.24	0.03	4.22	0.03	4.15	0.07	4.15	0.05	4.19	0.10	
Academic Outcome											
Lang & Lit Score	4.07	0.04	3.74	0.04	3.32	0.10	3.41	0.07	3.13	0.13	**1>2,3,4,5**** **2>3,4,5****

* $p < .05$, ** $p < .005$.

Table 23. Sixth grade child outcomes by ADHD symptom trajectories controlling for maternal education and sex, not ODD symptoms (Adjusted Means)

	ADHD Symptom Trajectory Groups										Group Comparisons
	Very Low (*N* = 410) (1)		*Low* (*N* = 446) (2)		*Low-Increasing* (*N* = 63) (3)		*High-Decreasing* (*N* = 116) (4)		*High Stable* (*N* = 46) (5)		
	M	*(SE)*	*M*	*(SE)*	*M*	*(SE)*	*M*	*(SE)*	*M*	*(SE)*	
Social Outcomes											
Mean SSRS	110.98	0.50	104.00	0.47	94.46	1.27	98.59	0.95	91.28	1.50	**1>2,3,4,5**** **2>3,4,5**** **4>5****
Friendship Quality	4.25	0.03	4.23	0.03	4.13	0.07	4.13	0.05	4.14	0.08	
Academic Outcome											
Lang & Lit Score	4.07	0.04	3.74	0.04	3.32	0.10	3.41	0.07	3.12	0.11	**1>2,3,4,5**** **2>3,4,5****

* $p < .05$, ** $p < .005$.

Table 24. Sixth grade child outcomes by ODD symptom trajectories controlling for maternal education, sex, and ADHD symptoms (Adjusted Means)

	ODD Symptom Trajectory Groups						
	Very Low (*N* = 742) (1)		*Low* (*N* = 296) (2)		*High* (*N* = 43) (3)		Group Comparisons
	M	*(SE)*	*M*	*(SE)*	*M*	*(SE)*	
Social Outcomes							
Mean SSRS	107.25	0.37	100.68	0.59	95.08	1.56	**1>2,3 **** **2>3 ****
Friendship Quality	4.25	0.02	4.15	0.03	4.11	0.09	
Academic Outcome							
Lang & Lit Score	3.74	0.03	3.86	0.05	3.92	0.12	

* $p < .05$, ** $p < .005$.

Table 25. Sixth grade child outcomes by ODD symptom trajectories controlling for maternal education and sex, Not ADHD symptoms (Adjusted Means)

	ODD Symptom Trajectory Groups						
	Very Low (*N* = 742) (1)		*Low* (*N* = 296) (2)		*High* (*N* = 43) (3)		Group Comparisons
	M	*(SE)*	*M*	*(SE)*	*M*	*(SE)*	
Social Outcomes							
Mean SSRS	108.64	0.37	98.19	0.58	88.30	1.53	**1>2,3 **** **2>3 ****
Friendship Quality	4.26	0.02	4.13	0.03	4.07	0.08	**1>2****
Academic Outcome							
Lang & Lit Score	3.86	0.03	3.63	0.05	3.30	0.12	**1>2,3**** **2>3***

* $p < .05$, ** $p < .005$.

6.7.1 ADHD symptom trajectories

6.7.1.1 Social outcomes at 6th grade: Parent and teacher reported social skills and self-reported friendship quality

When ADHD symptom trajectories were compared on a composite of parent and teacher ratings of children's social skills at 6th grade with all covariates in the model, a significant main effect was found for children's social skills (F (4,1069) = 20.78, $p < .001$, $\eta_p^2 = .072$); all three covariates, ODD symptoms (F (1,1072) = 165.87, $p <.001$, $\eta_p^2 = .134$), child sex (F (1,1072) = 8.29, $p = .004$, $\eta_p^2 = .008$), and maternal education (F (1,1072) = 40.16, $p < .001$, $\eta_p^2 = .036$) were also significant. Pairwise comparisons revealed that children in the *Very Low* symptom trajectory were rated as having significantly higher levels of social competence at 6th grade than those children in the *Low, Low-Increasing, High-Decreasing,* and *High Stable* trajectory groups. Children in the *Low* group were also rated as having significantly better social skills than were children in the *Low-Increasing* group.

Additional significant pairwise comparisons were obtained when concurrent ODD symptoms were not controlled (see Table 23). For example, the social skills of children in the *Low* trajectory group were rated, on average, as superior to the social skills of children in the *High-Decreasing* and *High Stable* trajectories. Furthermore, children in the *High-Decreasing* group were also rated as higher in social competence than children in the *High Stable* ADHD symptom trajectory.

No significant differences in self-reported friendship quality were found as a function of ADHD trajectory groups in either the analyses that controlled for concurrent ODD symptoms (F

(4,1069) = 0.58, p = .674, η_p^2 = .002) or those that did not (F (4,1070) = 1.53, p = .192, η_p^2 = .006).

6.7.1.2 Academic outcome at 6th grade: Teacher rated language and literacy skills

Academic performance at 6th grade, operationalized by teacher-reported proficiency in language and literacy skills, differed significantly as a function of ADHD symptom trajectory (F (4,1069) = 21.97, p < .001, η_p^2 = .076). Of the three covariates, only maternal education was a significant predictor of academic performance (F (1,1072) = 115.25, p < .001, η_p^2 = .097); neither child sex (F(1,1073) = 0.91, p = .341, η_p^2 = .001) nor concurrent symptoms of ODD (F(1,1073) = 0.02, p = .893, η_p^2 = .000) were significant. Children in the *Very Low* trajectory group were rated as superior to all the other groups in academic achievement (*Low*, *Low-Increasing*, *High-Decreasing*, and *High* trajectory groups), as were children in the *Low* trajectory group in comparison to children in the three higher symptom trajectory groups. Not surprisingly, the same results were obtained when concurrent ODD symptoms were not controlled. Complete results may be found in Tables 22 and 23.

6.7.2 ODD symptom trajectories

6.7.2.1 Social outcomes at 6th grade: Parent and teacher reported social skills and self-reported friendship quality

Symptoms of ODD in middle childhood were significantly associated with parent and teacher rated social competence in 6th grade (F (2,1073) = 51.24, p < .001, η_p^2 = .087) after controlling for maternal education (F (1,1074) = 38.42, p <.001, η_p^2 = .035), child sex (F (1,1074) = 10.52, p = .001, η_p^2 = .010), and concurrent symptoms of ADHD (F (1,1074) =

127.55, p <.001, η_p^2 = .106). Contrary to the hypothesis, significant differences were found between all of the ODD trajectory groups. The *Very Low* and *Low* ODD symptom groups were rated by teachers and parents as having better social skills than the *High* group and, furthermore, the *Very Low* ODD trajectory group was rated as more socially competent than the *Low* group (see Table 25). The same results were obtained when concurrent symptoms of ADHD were not controlled (see Table 26).

Although a significant main effect was obtained for self-reported friendship quality for as a function of ODD symptom trajectory group (F (2,1075) = 3.04, p = .048, η_p^2 = .006), none of the pairwise comparisons were significant (see Table 24). Maternal education and concurrent symptoms of ADHD were not significant covariates, although not surprisingly, child sex was significantly associated with symptoms of ODD (F (1,1074) = 46.88, p < .001, η_p^2 = .042). A significant main effect was also obtained when ADHD symptoms were not controlled (F (2,1074) = 6.71, p = .001, η_p^2 = .012). Pairwise comparisons indicated that children in the *Very low* ODD trajectory group reported higher levels of friendship quality than did children in the *Low* trajectory group (see Table 25).

6.7.2.2 Academic outcome at 6th grade: Teacher rated language and literacy skills

As predicted, ODD symptoms were not significantly associated with academic performance (F (2,1073) = 2.64, p = .072, η_p^2 = .005) after controlling for maternal education (F (1,1074) = 102.04, p < .001, η_p^2 = .087), child sex (F (1,1074) = 0.02, p = .883, η_p^2 = .000), and concurrent symptoms of ADHD (F (1,1074) = 177.12, p < .001, η_p^2 = .141). In contrast, when concurrent symptoms of ADHD were not entered as a covariate, a significant association between symptoms of ODD and academic performance at 6th grade was found, F (2,1074) = 16.82, p < .001, η_p^2 = .030, over and above maternal education (F (1,1075) = 147.59, p < .001,

η_p^2 = .121) and child sex (*F* (1,1075) = 9.12, *p* = .003, η_p^2 = .008). When concurrent symptoms of ADHD were not included in the analyses, significant differences were found between each of the three ODD symptom trajectories; the *Very Low* group performed significantly better on average than the *Low* or *High* groups and the *Low* group performed significantly better on average than the *High* group. Tables 24 and 25 present the full results.

6.8 HYPOTHESIS 3B: ACADEMIC AND SOCIAL OUTCOMES WILL BE DIFFERENTIALLY ASSOCIATED WITH THE DUAL TRAJECTORY GROUPS

As outlined above under Hypothesis 2B, the additive hypothesis could not be fully tested, as the ODD symptom only trajectory group was too small for statistical analysis. However, analyses of covariance (ANCOVAs) were conducted to examine whether the *ADHD only* and the *Comorbid* group differed significantly on self-reported friendship quality, teacher/parent reported social competence, and academic performance at 6th grade. Maternal education and child sex were entered as control variables in these analyses.

6.8.1 Social outcomes at 6th grade: Parent and teacher reported social skills and self-reported friendship quality

Parents and teachers reported significantly higher levels of social skills in members of the *ADHD only* group in contrast to the *Comorbid* symptom group (*F* (1,45) = 5.832, *p* = .020, η_p^2 = .122) after controlling for maternal education (*F* (1,45) = 5.613, *p* = .023, η_p^2 = .118) and child sex (*F*

(1,45) = 2.439, p = .126, η_p^2 = .055). In contrast, child-reported friendship quality at 6th grade did not differ significantly by joint symptom group membership.

6.8.2 Academic outcomes at 6th grade: Teacher rated language and literacy skills

The *ADHD only* and the *Comorbid* trajectory groups did not differ significantly in Academic performance (F (1, 45) = 0.776, p = .383, η_p^2 = .018), after controlling for maternal education and child sex.

7.0 DISCUSSION

The purpose of the present study was threefold: 1) to identify longitudinal patterns of DSM-IV symptoms of ADHD, ODD, and their co-occurrence in a community sample of children studied from 3rd to 6th grade; 2) to examine the differential associations between trajectories of ADHD and ODD symptoms assessed in middle childhood and earlier child- and family-based predictors; and 3) to investigate whether academic and social outcomes varied as a function of distinct symptom trajectories and their co-occurrence.

Consistent with hypotheses, five distinct longitudinal patterns of ADHD symptoms were identified including two trajectory groups exhibiting very low to low levels of symptoms, one trajectory group manifesting increasing symptoms, another showing decreasing symptoms, and a small minority of the sample (4%) demonstrating high stable levels of ADHD symptoms between 3rd and 6th grade. Contrary to prediction, however, only three trajectories of ODD symptoms were identified. While the final trajectory model included the hypothesized low and high stable symptom groups, it did not include increasing or decreasing symptom trajectories. Partial support for the hypotheses regarding the co-occurrence of ADHD and ODD symptoms over time between 3rd and 6th grade was found using cross-classification analyses. Not surprisingly given the community nature of the sample, the majority of children exhibited very low or low symptoms of both ADHD and ODD. In addition, a substantial proportion of the children who exhibited high levels of ADHD symptoms also exhibited high levels of ODD

symptoms. Furthermore, a small group of children demonstrating high levels of ADHD symptoms and low levels of ODD symptoms were identified. However, contrary to expectation, very few children exhibited high levels of ODD symptoms exclusively; indeed, none of the children in the *High* ODD symptom trajectory simultaneously exhibited *Very Low* levels of ADHD symptoms. Therefore, the dual symptom trajectories did not fully converge and it was not possible to explore dual symptom trajectories as proposed.

Partial support was obtained for the second set of hypotheses regarding the differential relations between the symptom trajectories and earlier measures of child and family functioning. As expected, early measures of child executive function predicted later levels of ADHD symptoms even after controlling for concurrent ODD symptoms. Conversely, ODD symptoms were not predicted by early executive function abilities when ADHD symptoms were controlled, with the one exception of planning ability, operationalized by performance on the Tower of Hanoi at 1st grade. In line with hypotheses, early maternal sensitivity predicted later ODD and ODD+ADHD symptoms, although the predictive relation was more robust when concurrent ADHD symptoms were not controlled (i.e. ODD+ADHD). Interestingly and contrary to expectations, harsh maternal control predicted combined ODD+ADHD symptoms, but not ODD symptoms alone. Finally, early parenting predicted later ADHD symptoms after controlling for concurrent ODD symptoms; however, in line with the results reported above, associations were stronger when ODD symptoms were not controlled in the analyses.

Because it was not possible to fully parse the joint trajectory groups into ADHD, ODD, and combined ODD and ADHD trajectories, only a portion of the hypothesis that the additive combination of elevated ADHD and ODD symptoms, i.e. the *Comorbid* group, would be more strongly predicted by earlier risk factors compared to *ADHD* and *ODD only* joint symptom

groups was tested. Contrary to expectation, neither early executive function measures nor early parenting measures significantly predicted greater likelihood of being in the *Comorbid* group in contrast to the *ADHD only* group.

Finally, partial support was also found for the third set of hypotheses regarding the relation between symptom trajectories and social and academic outcomes at 6th grade. As predicted, academic performance was associated with ADHD symptoms after controlling for concurrent levels of ODD symptoms, but not with ODD symptoms alone. Furthermore, ADHD symptom levels were also significantly associated with mother- and teacher-reported social skills, although not self-reported friendship quality, whether or not ODD symptoms were controlled in the analyses. In addition, social skills were also significantly associated with ODD symptom levels both before and after controlling for comorbid symptoms of ADHD; however, contrary to expectation, the association between ODD symptoms and social skills did not appear weaker than the relation between ADHD symptoms and social skills. The additive hypothesis regarding the joint symptom groups was partially born out. Children in the *Comorbid* symptom group had poorer social skills than children in the *ADHD only* group. However, neither child-reported friendship quality nor academic performance significantly differentiated between the *ADHD only* and *Comorbid* symptom groups at 6th grade.

7.1 TRAJECTORIES OF ADHD AND ODD SYMPTOMS AND THEIR CO-OCCURRENCE BETWEEN 3RD AND 6TH GRADE

7.1.1 ADHD trajectories

Based on a review of the extant literature, the current study provides the first examination of the developmental course of multi-informant rated DSM-IV symptoms of ADHD and ODD in both boys and girls across four time points during middle childhood in a community sample using a person-centered semi-parametric group-based modeling approach. Five distinct longitudinal trajectories of ADHD symptoms, varying in symptom level and developmental progression, were identified in this community sample. As expected, based on the low-risk, nature of the sample, the vast majority of children (79%) were assigned to *Very Low* and *Low* trajectory groups demonstrating, on average, fewer than 3 ADHD symptoms at any one time point.

A much smaller portion of the sample (6%) exhibited low levels of ADHD symptoms at 3rd grade (M = 3.76) which, after increasing in a consistent linear manner, more than doubled by 6th grade (M = 8.38): the *Low-Increasing* trajectory group. Although, this pattern of symptom increase has not been documented often in the literature examining either diagnostic retention or the developmental course of ADHD (Willoughby, 2003), we hypothesized that we might find a trajectory characterized by increasing levels of ADHD symptoms based on the controversy around the age of onset criteria in ADHD. As reviewed by Willoughby (2003), a number of studies investigating age of onset have found evidence for ADHD symptoms that emerge after age 7, even as late as adolescence, in a small proportion of youth. Further corroboration is provided for the identification of an increasing pattern of ADHD symptoms by two more recent studies (Langberg et al., 2008; Malone, Van Eck, Flory, & Lamis, 2010). Using growth mixture

modeling to examine parent-reported DSM-III ADHD symptom trajectories in a high-risk community sample of girls and boys from 3rd through 9th grade, Malone et al. (2010) found a class characterized by increasing ADHD symptoms between 3rd and 6th grade. Langberg and colleagues (2008) also reported an increase in parent-rated ADHD symptoms in their investigation of the relation between developmental trajectories of ADHD symptomatology and the transition to middle school, using the clinical sample from the Multimodal Treatment Study of Children with ADHD (MTA). This finding, however, was not replicated in their nonclinical comparison group, who displayed levels of symptoms more in line with those demonstrated by the *Very Low* and *Low* ADHD trajectory groups in the current study.

Some children (11%) in our study displayed a linear pattern of decreasing ADHD symptoms from 3rd grade (M = 8.22) to 6th grade (M = 4.07). This *High-Decreasing* trajectory mirrors the decrease in symptoms evidenced in the prior developmental course studies reviewed in the introduction (Biederman, Mick, & Faraone, 2000; Hart et al., 1995; D. S. Shaw et al., 2005). More recent studies investigating the longitudinal course of ADHD symptoms also find evidence for a decrease in ADHD symptoms across time in some children (Gau, Lin, et al., 2010; Gustafsson, Holmstrom, Besjakov, & Karlsson, 2010; Langley et al., 2009; P. Shaw, Gogtay, & Rapoport, 2010). Unlike the current study, but similar to the larger body of research to date, these studies use clinical samples and designs that fail to consider developmental timing, evidenced by the widely disparate developmental stages represented in their samples, which range from early school age through adolescence. Despite the heterogeneous samples, a decrease in ADHD symptoms was reported in these more recent studies as well. These results and those of the current study suggest that some children with earlier symptoms exhibit fewer

hyperactive, impulsive, and inattentive behaviors as they mature regardless of diagnostic status, the severity level of their symptoms, and the age at which the symptoms are occurring.

Finally, as hypothesized, a small proportion of the sample (4%) comprised the fifth trajectory group which was characterized by *High Stable* levels of ADHD symptoms, ranging between 10.17 and 11.40, from 3rd to 6th grade. This is not surprising given the results from earlier (Biederman et al., 2000; Hart et al., 1995; Willoughby, 2003), and more recent (Biederman, Petty, Clarke, Lomedico, & Faraone, 2011; Biederman, Petty, Evans, Small, & Faraone, 2010; Gau, Lin, et al., 2010; Langley et al., 2009; P. Shaw et al., 2010), diagnostic retention studies that all report persistence of high levels of ADHD symptoms in some children. Furthermore, D.S. Shaw and colleagues (2005) found a similar trajectory group in their community sample of high-risk boys with some demonstrating high persistent levels of hyperactive / attention problem behaviors from 2 to 10 years of age.

In summary, the five trajectory group model of ADHD symptoms derived using TRAJ from a low-risk, community sample of boys and girls across middle childhood supported all of the a priori hypotheses, which is of particular note given that the majority of the available studies employ either high-risk or clinical samples. The fact that our results replicate previous findings in samples that demonstrate more severe symptoms and ADHD diagnoses has implications regarding the qualitative differences between diagnostic and subthreshold levels of ADHD and lends further credence to the conceptualization of ADHD as a continuum or a dimension rather than a category. Finally, in line with a developmental psychopathology framework, these results add to our knowledge regarding the “normative” developmental course of ADHD symptoms in a community sample, which, in turn, provides a much-needed comparison for determining whether

disruptive behavior is atypical or problematic. By examining the association of these trajectories with potential predictors and outcomes, we will shed further light on these issues.

7.1.2 ODD trajectories

Another main aim of this study was to elucidate the developmental course of ODD symptoms across middle childhood in this community sample using DSM-IV symptom criteria. As far as we know, this is the first study to examine trajectories of DSM-IV defined ODD symptoms in this age range in a non-clinical sample of girls and boys, thereby providing the first opportunity to understand how ODD symptoms manifest in severity level and vary across development in a "normative" sample. Similar to our hypotheses for the ADHD trajectories, hypotheses regarding the number and shape of the ODD trajectories were based on prior studies that differed in important methodological ways from the current study. For example, out of the four studies that we found attempting to adhere to DSM-IV symptom criteria, two of them examined the persistence of an *ODD diagnosis*, i.e. diagnostic retention studies (Costello et al., 2003; Rowe et al., 2002). Although the remaining two studies (Bongers et al., 2004; van Lier et al., 2007) examined longitudinal trajectories of ODD symptom levels in 4 to 18 year olds, they both employed a different combination of CBCL items, rather than the DSM-IV symptom criteria, to measure ODD symptoms. Based on the results of these studies, we hypothesized that we would identify four trajectories of ODD symptoms with the majority of children displaying low symptom levels across time, a small proportion of children demonstrating high stable levels of ODD symptoms, and the rest of the children split between two trajectories characterized by increasing and decreasing symptom levels.

Contrary to expectation, only three trajectories of ODD symptoms were found. Furthermore, in contrast to those evidenced in the community samples of van Lier and colleagues (2007) and Bongers et al. (2004), no increasing or decreasing trajectories of ODD symptoms were evident in our data. However, as predicted, the majority of study children consistently exhibited *Very Low* and *Low* symptoms of ODD, ranging from a mean of 0.08 to 1.36 symptoms out of a possible total of 6. In addition, a small minority of our sample exhibited higher levels of ODD symptoms (M = 3.51 to 4.04: diagnostic symptom criteria are met by 4 or more symptoms out of a possible 6) that persisted through middle childhood. Our slightly divergent results are most likely due, in part, to methodological differences such as varied measures and age ranges that have been discussed above.

The slight inconsistencies between these results and the two prior studies may also be accounted for by the *source* of the ODD ratings. A recent study conducted by Munkvold, Lundervold, Lie, and Manger (2009) provides evidence for an "informant-specific conceptualization of childhood ODD." These researchers reported differences in ODD prevalence estimates in a community sample of girls and boys ranging from 7 to 9 years old depending on how parents' and teachers' ratings were combined. More specifically, the highest prevalence rate (2.6%) was witnessed when symptom presence was reported using the "or-rule" i.e. a symptom was counted if rated present by either the parent *or* the teacher. Parents and teachers were found to co-identify very few children resulting in the lowest prevalence rate (0.2%) when the "and-rule" (requiring symptom endorsement by both parent and teacher) was applied. Not surprisingly, children identified by the *and-rule* were rated as most impaired by both teachers and parents suggesting that children with multiple-source ODD are more severely affected than those with informant-specific ODD. Munkvold and colleagues' results may

partially explain the restricted distribution of ODD trajectories evident in the current study. Indeed, the low correlations found between mother and teacher reported symptoms of ODD at each time point (r =.21 to r = .27, $p \leq .01$) and across time points (r =.09 to r = .27, $p \leq .01$), lend statistical support to this supposition. Employing stringent criteria akin to the "*and-rule"* in the current study to measure ODD symptoms may be responsible for the low rates of observed ODD symptoms. Using the more stringent *and-* criteria may have concealed a wider range of informant-specific ODD symptom counts which, in turn, may have constituted increasing and decreasing trajectories of ODD symptoms. Interestingly, the studies where increasing and decreasing trajectories of ODD symptoms were observed used single-informant ratings of ODD – specifically parents (Bongers et al., 2003; van Lier et al., 2007).

7.1.3 Dual trajectories

In line with previous studies examining the co-occurrence of symptoms of distinct clinical disorders (Nagin & Tremblay, 2001; D. S. Shaw et al., 2005), we initially employed a dual trajectory model to examine the linkages between the developmental course of ADHD and ODD symptoms. In contrast to previous studies, however, the dual trajectory model in the current study did not converge due to small cell sizes. For example, very few children exhibited *High* ODD symptoms, and consequently there were no children who exhibited *High* ODD and *Very Low* ADHD symptoms. This led, in part, to the model failure. Given the non-clinical and non-high risk nature of our sample, the low prevalence rates of ODD are not surprising. This null finding serves to highlight one of the unique aspects of this study, i.e. the use of a community sample, and underlines an important difference in ODD symptom severity and comorbidity rates between community and clinical/high-risk samples.

Using cross-classification analysis, we found, as predicted, that a substantial proportion of the children demonstrating elevated levels of ADHD symptoms also evidenced concurrent elevated levels of ODD symptoms. In fact, 43% of children in the *High Stable* ADHD symptom trajectory were also classified in the *High* ODD symptom trajectory. These results are in line with the large body of empirical literature supporting significant *concurrent comorbidity* between ADHD and ODD symptoms in both community and clinical samples of boys and girls between 2 and 17 years of age (Angold et al., 1999; Biederman et al., 1991; Gau, Hsing-Chang, et al., 2010; Pliszka, 2000). Interestingly, the *High-Decreasing* and *Low-Increasing* ADHD groups, which differ in the direction of their symptom course but demonstrate very similar ranges of symptom levels (see Table 9), do not evidence the same overlap with the *High* ODD trajectory shown by the *High Stable* ADHD symptom trajectory. More specifically, in contrast to 43% of children in the *High Stable* ADHD symptom group, only 9% of the *High-Decreasing* and 11% of the *Low-Increasing* ADHD symptom groups exhibit concurrent *High* levels of ODD symptoms across middle childhood indicating that the *longitudinal stability* of High ADHD symptoms confers greater risk of, or is more clearly associated with, comorbid ODD than are elevated ADHD symptoms at one time point. This finding would have been obscured in a cross-sectional study and, thereby, further highlights the importance of looking at symptom development across time.

Based on prior research (Angold et al., 1999; Greene et al., 2002; Martel, Gremillion, Roberts, von Eye, & Nigg, 2010; Maughan et al., 2004) supporting the diagnostic independence of ADHD from ODD, as well as current DSM-IV classifications (American Psychiatric Association, 1994), we predicted that our dual trajectory groups would also include an *ADHD only* group comprised of children demonstrating elevated ADHD symptoms and concurrent low

ODD symptoms and, conversely, an *ODD only* group. As predicted, an *ADHD only* joint symptom group was identified. More specifically, a small proportion of the *High Stable* ADHD symptom group (9%) was cross-classified into the *Very Low* ODD symptom trajectory, which exhibited near-zero ODD symptom levels across time. In addition a substantial proportion of the *High Stable* ADHD trajectory (48%) was classified into the *Low* ODD group.

Contrary to expectation, as already noted, none of the study children were simultaneously classified into the *High* ODD and *Very Low* ADHD symptom trajectories i.e. an *ODD only* group. Although this null finding appears contrary to the DSM-IV conceptualization of ODD and ADHD as distinct disorders, there are instances of similar findings in the extant literature (D. S. Shaw et al., 2005; van Lier, Verhulst, van der Ende, & Crijnen, 2003). These mixed findings may be an artifact of methodological differences, such as informant-source, sample characteristics, and study design. Alternatively, it may indicate an important qualitative difference in normative patterns of covariation of subthreshold, versus diagnostic, levels of ODD and ADHD symptoms.

Finally, as expected, the overwhelming majority of children (64%) in our community sample exhibited *Very Low* or *Low* levels of ADHD and *Very Low* ODD symptoms. Given the low-risk nature of the current sample and prevalence rates of ADHD and ODD ranging between 1 and 20% (Nock et al., 2007; Polanczyk, Lima, Horta, Biederman, & Rohde, 2007), it is not surprising that most of the study children exhibited two or fewer ADHD symptoms and less than one ODD symptom on average across middle childhood.

7.2 DIFFERENTIAL PREDICTORS OF ADHD AND ODD SYMPTOM TRAJECTORIES AND THEIR COVARIATION

Consistent with hypotheses and the existing literature (Deault, 2010; Ellis & Nigg, 2009; Johnston & Mash, 2001; Modesto-Lowe, Danforth, & Brooks, 2008), our findings regarding the differential relation of parenting to ADHD, ODD, and ADHD+ODD trajectories were mixed. As hypothesized, early maternal sensitivity predicted later ODD, ODD+ADHD, and ADHD symptoms. In addition, early harsh maternal control predicted later ADHD, ADHD+ODD, and ODD+ADHD symptoms, but contrary to expectation, it did not significantly predict ODD symptoms alone. These results lend general support to the widely reported association between negative parenting and disruptive behaviors (Deault, 2010; Johnston & Mash, 2001; Modesto-Lowe et al., 2008). The literature contains multiple theories explicating possible unidirectional and bidirectional pathways between parenting and child problem behaviors, such as Patterson's Theory of Coercive Family Process (1982), Baumrind's description of Parenting Style (1966, 1967), and Attachment Theory (Ainsworth, Blehar, Waters, & Wall, 1978). In line with these models, the findings from the current study highlight potential parenting factors that may contribute to the development and maintenance of later ADHD and ODD symptoms. For example, our findings demonstrate that early negative parenting, evidenced in low maternal sensitivity and high harsh maternal control, which, according to Patterson's Theory would contribute to persistent and escalating coercive exchanges and have long-standing effects on children's development, predict, as would be expected, later levels of elevated ADHD and ODD symptoms characterized by noncompliance, aggression, and poor regulation. Alternatively, our findings also lend support to Baumrind's model, which states that authoritarian parenting, characterized, in part, by low parental warmth and harsh control, provides negative modeling and

leads to deficits in a child's ability to self-regulate and engage in appropriate social behavior – both of these are hallmarks of ADHD and ODD symptoms. Finally, Attachment Theory identifies parental sensitivity as a key base of secure attachment which, in turn, facilitates the development of, among others, self-regulation skills. The predictive relation found in the current study between early levels of low maternal sensitivity and later elevated symptoms of ADHD and ODD provides partial support for the pathway between low levels of early maternal sensitivity and later disruptive behaviors characterized by dysregulation and noncompliance.

By controlling for comorbid ADHD and ODD symptoms, the current study also provides insight into the *specific* relation between early parenting factors and later levels of ADHD, ODD and ADHD+ODD symptoms. For instance, early *maternal sensitivity* predicted both ODD and ADHD symptoms before and *after* controlling for comorbid ADHD and ODD symptoms indicating that *both* ADHD and ODD symptoms are uniquely and independently associated with early levels of maternal sensitivity. Furthermore, the predictive associations were more robust before comorbid symptomatology was controlled, in that early maternal sensitivity predicted differential membership between a greater number of trajectory groups, suggesting that the predictive association is stronger in the presence of comorbid ADHD and ODD symptoms. Despite this finding, however, and contrary to expectation, early maternal sensitivity did not predict joint symptom group membership in the joint symptom group analyses: no difference was found between the *ADHD alone* and the *Comorbid* groups. This may be due to the manner in which the *ADHD alone* group was formed. Both the *Very Low* and the *Low* ODD trajectory groups cross classified into the *High Stable* ADHD symptom trajectory were included in the *ADHD alone* group. This configuration may be too inclusive thereby increasing within-group

variance and masking any significant differences. Small cell sizes may also account for this apparent discrepancy.

In addition to the results discussed above, aspects of the particular methodology employed in the current study may help to shed light on some of the mixed findings in the literature (See for review: Deault, 2010; Johnston & Mash, 2001; Modesto-Lowe et al., 2008). Prior studies have failed to account for comorbidity between ADHD and ODD symptoms, subthreshold symptom level, developmental timing and course of symptoms, and different parenting measures simultaneously, all of which demonstrated unique patterns of findings in the current study. The use of symptom counts, rather than categorical diagnoses, is of particular note as the current results highlight that subthreshold symptoms are, indeed, associated with early parenting. These results support the importance of, and need to, control for comorbid symptoms dimensionally, not just categorically.

Our results also provide cumulative support for a *specific* association between executive function deficits and symptoms of ADHD in contrast to ODD symptoms because concurrent symptoms of ADHD and ODD were controlled. Thus, the current study differentiated between executive function deficits as predictors of ADHD and ODD symptoms. Similar to results of prior studies (Berlin & Bohlin, 2002; Brocki et al., 2007; Nigg et al., 1998; Oosterlaan et al., 2005; Speltz, DeKlyen, et al., 1999; Thorell & Wahlstedt, 2006), early deficits in inattention, impulsivity, delay of gratification, and planning predicted later ADHD symptoms both before and *after* controlling for concurrent ODD symptoms. In contrast, deficits in inattention, impulsivity, and delay of gratification did not significantly predict ODD symptoms *after* controlling for symptoms of ADHD. These results are important for multiple reasons.

First, they provide initial evidence that deficits in delay of gratification are specifically associated with symptoms of ADHD and not ODD; only one other study, that we know of, has examined this relation while controlling for comorbid ODD (Gupta, Kar, & Srinivasan, 2011). Second, the current results lend support to etiological models of ADHD centered on disrupted neuropsychological processing and associated deficits (Nigg, 2005). The specificity of the associations also provides evidence that ADHD and ODD symptoms are reflected in different underlying processes, consistent with the argument that they are distinct disorders. Third, the fact that executive function deficits differentially predict later ADHD, but not ODD, symptoms lends validity to conceptualizing these early deficits as potential markers, or risk factors, for the later development of elevated symptoms of ADHD. Consequently, testing for early executive function deficits may aid in identifying at-risk children for prevention and intervention efforts. In turn, the significant predictive associations found in the current study, help identify executive function deficits as a possible domain of functioning that could be targeted in intervention and prevention programs.

Another important contribution of the current study is the examination of this relation as a function of symptom trajectory, which can also be thought of as a representation of symptom severity or level over time. The vast majority of previous studies have identified their groups based on, at least in part, diagnostic symptom cut-off scores, and as a result do not have the ability to examine the differential prediction of varying symptom levels over time as a function of executive function. By employing symptom trajectories, the current study demonstrates that executive function deficits are in step with later symptom severity i.e., the worse the early executive function deficit the higher the likelihood of membership in a later trajectory characterized by higher levels of ADHD symptoms. This is important as it provides information

regarding the relation between executive functioning and subthreshold levels of ADHD and ADHD+ODD. More specifically, it provides support for conceptualizing the relation between executive functions deficits and ADHD / ADHD+ODD as continuous, i.e. executive function deficits and ADHD / ADHD+ODD symptoms increase in tandem, rather than categorical, i.e. executive function deficits predict ADHD symptoms above a certain threshold.

One exception to the general pattern of results was evidenced by planning ability, which, contrary to prediction, significantly predicted ODD symptoms *before*, and not after, controlling for concurrent symptoms of ADHD. Oosterlaan and colleagues (2005) have conducted the one study to date which has examined the relation between ODD symptoms, while controlling for comorbid symptoms of ADHD, and planning; ODD symptoms were found *not* to be significantly associated with planning after ADHD symptoms were controlled. The current finding is an anomaly in the research literature, and is conceptually contradictory, suggesting that it may be a methodological artifact. Nonetheless, it warrants further scrutiny and the relation between ODD symptoms and planning should be explored in future studies.

Overall, our results replicate findings in the existing literature that document significant associations between executive function deficits and ADHD, and ADHD+ODD; however, the current study adds to the extant literature by controlling for concurrent levels of comorbid ADHD and ODD symptoms in the analyses, thereby demonstrating that the relation between inattention, impulsivity, and delay is specific to symptoms of ADHD rather than ODD.

7.3 THE DIFFERENTIAL ASSOCIATION OF SOCIAL AND ACADEMIC OUTCOMES WITH ADHD AND ODD SYMPTOM TRAJECTORIES AND THEIR COVARIATION

In line with our hypotheses, and previous research, elevated symptoms of ADHD and ODD over time were associated with negative social and academic outcomes. More specifically, elevated levels of ADHD symptoms were associated with mother- and teacher-reported social skills deficits, although not self-reported friendship quality, whether or not ODD symptoms were controlled in the analyses. A significant association was also found between symptoms of ODD and social skills both *before* and *after* controlling for concurrent symptoms of ADHD. Furthermore, when concurrent ADHD symptoms were not controlled in the analyses, ODD symptoms were associated with self-reported friendship quality. Results from the joint symptom groups lend support to the additive conceptualization of ADHD +ODD symptoms, demonstrating that children in the *Comorbid* group exhibited significantly worse social skills than children in the *ADHD only* group. In line with the univariate trajectory results, no significant difference was found between these two groups in terms of self-reported friendship quality.

Finding significant associations between social skills deficits and earlier, longitudinal patterns of subthreshold ADHD and ODD symptoms is particularly important because it provides evidence that subthreshold symptoms also predict negative social outcomes, thereby indicating that the mixed findings in the literature may be partially due to unaccounted for comorbid subthreshold symptomatology. Consequently, these results strongly suggest that comorbid symptoms, rather than diagnostic status, should be controlled in future studies

investigating the specificity of associations between negative social outcomes and disruptive behavior disorders.

Furthermore, as predicted, poor academic performance was associated with elevated levels of ADHD symptoms both before and *after* controlling for concurrent levels of ODD symptoms, but not with ODD symptoms alone. Contrary to expectation, but not surprisingly given the univariate results, academic performance was not associated with *ADHD only* versus *Comorbid* group membership. By examining these associations while controlling for concurrent comorbid symptoms, the results from the current study help to elucidate the differential relation between symptoms of ADHD, ODD, ADHD+ODD and academic performance. Furthermore, the current study employs methodologies that increase the generalizability of these results, such as using DSM-IV symptom criteria, employing a community sample, and examining symptom dimensions rather than categorical diagnoses.

8.0 STRENGTHS, LIMITATIONS, AND FUTURE DIRECTIONS

The current study extends the extant research findings in several important ways. First, using a person-centered statistical approach, the current study provides the first model of the *developmental trajectories* of DSM-IV ODD and ADHD symptoms during *middle childhood* using a *normative sample*. Second, using these explicated developmental trajectories, this study examines the differential associations between varying levels and courses of ADHD and ODD symptoms (i.e. intra-trajectory groups) and predictors and outcomes. Third, this study provides clarification regarding the unique and differential associations between DSM-IV ADHD symptoms, DSM-IV ODD symptoms, predictors, and outcomes by controlling for the potential confounding effects of comorbid disruptive symptoms. Finally, this study examines these questions within a developmental context i.e. associations between predictors, disruptive symptoms, and outcomes are examined from preschool through 6th grade.

Explicating and examining the developmental trajectories of ADHD and ODD symptoms provides several advantages compared to studies that examine cross-sectional levels of ADHD and ODD symptoms. Modeling developmental trajectories supplies a powerful illustration of the "developmental course" of ADHD and ODD symptoms in a normative sample. In addition, the developmental trajectories provide valuable information about the very *existence* of heterogeneous symptom trajectories as well as the "normative" ebb and flow of symptom levels across time. Furthermore, developmental trajectories capture different individuals than methods

using cross-sectional threshold criteria and, therefore, reveal differential associations with psychosocial risk factors and outcomes. Finally, studying maladaptive behavior from a developmental perspective, rather than using a symptom snapshot from one time point, is in line with a developmental psychopathology approach that asserts that behavior must be seen and studied in the context of development in order to maximize accurate representation of, and subsequent understanding of, the phenomena of interest.

The analyses conducted in the current study examining the relation of predictors and outcomes to the various trajectory groups provide valuable information regarding the differential associations between varying symptom levels and risk factors and outcomes. Broadly speaking, our pattern of findings suggests a threshold effect but a threshold that is lower than the DSM-IV diagnostic threshold. For example, significant differences in errors of commission were found between the low and high ADHD symptom trajectories but not between the high groups suggesting a threshold effect i.e. evidencing higher levels of errors of commission in preschool predicts to higher levels of ADHD symptoms in middle school, both moderate and very high levels. These results also highlight the potential confounding effect that *uncontrolled* subthreshold symptoms present.

The current study also provides evidence of differential associations between trajectories of DSM-IV ADHD and ODD symptoms, earlier risk factors, and later outcomes while controlling for comorbid disruptive symptoms. The use of DSM-IV symptoms of ADHD and ODD is emphasized as it has the advantage of providing some standardization to the results. However, the focus on DSM-IV symptoms is not meant to suggest that they are infallible and, indeed, the findings of the current study have implications for the way in which ADHD and ODD are conceptualized as manifested in the symptom criteria used by DSM-IV. For example,

DSM-IV symptoms suggest that ODD is manifested in disrupted relationships and social interactions, whereas ADHD manifests more broadly in difficulty regulating behavior and skills required to accomplish tasks such as attention, and impulsivity. Interestingly, and somewhat contrary to this conceptualization, the findings of this study indicate that early parenting, maternal sensitivity in particular, is not uniquely associated with later symptoms of ODD, symptoms but rather predicts elevated levels of both ODD and ADHD symptoms in middle childhood. Alternatively, the current results also provide support for the DSM-IV conceptualization in that executive function deficits at 54 months, indicating underlying general regulation deficits, were found to uniquely predict symptoms of ADHD, but not ODD, in middle childhood.

Finally, the current study examines all of these questions within a developmental context. Despite the wide time span, significant relations were found between risk factors measured at 54 months and first grade and symptom trajectories during middle childhood as well as outcomes at 6th grade. These results provide evidence of developmental precursors 6 – 7 years prior to symptom trajectories. Furthermore, the strength of these associations is further attested to by the use of different, and multi- informants for each measure at each time point.

When interpreting the results, it is also important to consider the limitations of the current study. First, the lack of a measure of functional impairment, and consequent lack of true diagnosis, restricts generalizability and comparability of the current results to those using DSM-IV diagnoses. Furthermore, the absence of a measure of functional impairment clouds our ability to interpret the clinical significance of the longitudinal symptom patterns in terms of DSM-IV. Second, although a major aim of the current study was to examine the specificity of the association between symptoms of ADHD, ODD and predictors and outcomes, other potential

comorbid symptomatology was not controlled in the analyses introducing possible confounding effects. Third, the DBD Rating Scale used to assess symptoms of ADHD and ODD, like the DSM-IV, assumes that diagnostic criteria are equally applicable at all developmental time points. As hyperactive, inattention, impulsive, and oppositional behavior may manifest differently over time (Willoughby, 2003), the a-developmental nature of the symptom criteria may obscure the "real" developmental course of these symptoms. For example, it has been suggested that the decline in ADHD associated with age may reflect the developmental insensitivity of the DSM-IV rather than the natural course of ADHD (Biederman et al., 2010). Fourth, employing a community sample and using "*and"* criteria to identify ODD symptoms, restricted the range of symptoms reported in our sample. These factors, in turn, may have affected the shape and number of ODD trajectories found in the analyses, which, ultimately, could have led to the failure of the dual trajectory model analyses. Finally, the current study did not examine the results as a function of sex differences.

Future studies would benefit by improving upon some, if not all, of the limitations cited above. A thorough investigation of sex differences in terms of the developmental trajectories of ADHD and ODD symptoms as well as their associations with potential predictors and outcomes should be undertaken in order to advance our understanding of potential sex effects. In the same vein, the potential effects of symptom subtypes should also be examined in terms of developmental trajectories and potential correlates. Finally, the nature of the relations between the symptoms, predictors, and outcomes should be teased apart further, for example by examining the reciprocal nature of the relations between symptoms, predictors, and outcomes. In addition, the nature of the pathways between predictors, symptoms, and outcomes should be studied further. For example, there is evidence in the literature suggesting that executive

function deficits mediate the association between ADHD and negative social outcomes (Huang-pollock, Mikami, Pfiffner, & Mcburnett, 2009).

9.0 SUMMARY AND CONCLUSIONS

The current study makes important contributions to the literature. By identifying and delineating developmental trajectories of ADHD and ODD symptoms, it has expanded our understanding of the developmental course of ADHD and ODD symptoms in a community sample across middle childhood. The ADHD trajectories evidenced in the current study provide support for heterogeneous pathways (Nigg et al., 2005), and, more specifically, the *High-Decreasing* and *Low-Increasing* ADHD symptom pathways provide evidence for multi- and equifinality. The results also reveal differential associations between predictors, outcomes, and varied trajectories of ADHD and ODD symptoms. The significant associations between varying longitudinal subthreshold symptom trajectories and correlates lend support to the conceptualization of ADHD as a continuum versus a category. In addition, by providing evidence that subthreshold symptoms can be significantly related to earlier risk factors and later negative outcomes, the current findings highlight that subthreshold symptoms are associated with impairment and emphasize the need to control for comorbid symptoms dimensionally, not just categorically, in order to parse out the specific effects of disorders.

By clarifying which predictors and outcomes are associated specifically with ADHD, ODD, or ADHD+ODD symptoms, the current study helps to provide evidence for the existence of separate symptom syndromes or, conversely, provides evidence for underlying commonalities and/or shared symptom expression. Further, this study found both common and specific

associations in line with the bifactor model of ADHD and ODD reported in a recent study (Martel et al., 2010). After examining several different factor models, the authors concluded that a bifactor model best fit the data, which included both a common "g factor" underlying ADHD and ODD, as well as distinct ADHD and ODD component factors. In summary, the results from the current study aid in clarifying nosology and provide support for the conceptualization of ADHD and ODD as two distinct disruptive domains with a common underlying factor.

In addition, the findings regarding the predictors and outcomes also provide important information for intervention and prevention efforts. By elucidating which predictors and negative outcomes are associated with which disruptive symptoms, the results highlight potential early markers that may be used to identify at-risk children for prevention and intervention programs, as well as identifying deficient skills and aspects of parenting to target in intervention efforts.

The current study attempted to use methodology in line with a developmental psychopathology framework, thereby filling an important hole in the extant literature outlined by Drabick and Kendall (2010). By using a community sample and examining "normative" trajectories of ADHD and ODD symptoms across time, the current study provides a "normative" comparison, deemed crucial from a developmental psychopathology perspective, which may be used as a yardstick in determining what levels of problem behaviors are typical versus atypical. Another potential advantage of employing a community sample, rather than a clinical sample, is its ability to provide a better representation of a child with a disorder in the general population. Children presenting in treatment settings have been found to display more severe symptomatology and impairment, and to come from families that feel more burdened by their child's problems, than children with psychiatric disorders who do not seek treatment (Drabick &

Kendall, 2010). Finally, using a community sample enabled the current study to examine dimensional (subdiagnostic) symptoms of ADHD and ODD.

The developmentally informed design of the current study is also in line with a developmental psychopathology framework. Not only did the current study examine patterns of ADHD and ODD symptoms as a function of age, the data were collected from a same-age sample at similar time points thereby rendering the associations found between the variables developmentally specific. The longitudinal design of the study captures natural behavior change across time, which is obscured in cross-sectional designs. In addition, the multi-informant measures reduce informer bias and add validity to the associations found as they remain across-informant.

Finally, although this study adds significantly to the current body of research, there is still more work to be done. The bidirectional and transactional nature of the associations between disruptive symptoms, predictors, and outcomes need to be fully explored. Other contributing factors, such as sex, demographic variables, and symptom subtypes, should also be investigated. In addition, methodological considerations, such as the potential effects of grouping criteria and informant source need to be more fully explicated. Longitudinal data sets like the NICHD Study of Early Child Care and Youth Development provide the rare and invaluable opportunity to examine these questions using a large, prospective, multi-site, community data set.

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