# THE DEVELOPMENTAL COURSE OF HYPERACTIVE-IMPULSIVE AND INATTENTIVE (HIA) BEHAVIOR IN A COMMUNITY SAMPLE OF GIRLS:  A GROUP-BASED MODEL OF DEVELOPMENT FROM KINDERGARTEN TO FIFTH GRADE

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# THE DEVELOPMENTAL COURSE OF HYPERACTIVE-IMPULSIVE AND INATTENTIVE (HIA) BEHAVIOR IN A COMMUNITY SAMPLE OF GIRLS:  A GROUP-BASED MODEL OF DEVELOPMENT FROM KINDERGARTEN TO FIFTH GRADE

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The goal of the present study was to extend our current understanding of the female-specific manifestations, developmental course, and outcomes of hyperactive-impulsive and inattentive (HIA) behaviors.  This study modeled the developmental trajectories of hyperactive-impulsive and inattentive behavior in a population-based study of girls followed from kindergarten to fifth grade.  Four trajectories of both hyperactive-impulsive and inattentive behavior were identified. Joint trajectory analyses revealed an association between the highest trajectories of hyperactive-impulsive behavior and inattentive behavior.  Similarly, the lowest level trajectories of both hyperactive-impulsive and inattentive behaviors showed a high degree of association.  Contrary to expectations and descriptions of ADHD in girls, the number of girls assigned to both the highest trajectories of inattentive behavior and the lowest trajectories of hyperactive-impulsive behavior was extremely low.  Teacher- and self-reported measures of child functioning varied by trajectory group membership across all models, suggesting that sub-clinical levels of HIA behavior are associated with adjustment difficulties in girls.

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# 1.0    INTRODUCTION

Attention-deficit/hyperactivity disorder (ADHD) has been a topic of rigorous investigation and intense debate for more than a century (Willoughby, 2003). Characterized by high rates of hyperactive, impulsive, and inattentive (HIA) behaviors and estimated to affect approximately seven percent of school-aged children (Scahill & Schwab-Stone, 2000), ADHD is one of the most easily recognized and frequently diagnosed childhood disorders. Because the highly disruptive nature of this disorder often interferes with children's functioning in multiple contexts, an ADHD diagnosis is among the most common reasons for clinical referral (Barkley, 1998; 2002), frequently requiring extensive services. Government spending on ADHD-related needs in the classroom alone exceeds billions of dollars annually (NIH Consensus Development Panel, 2000), earmarking this disorder for continuous research funding. This generous support has allowed investigators to create a large database of findings documenting the antecedents, correlates, course, treatment-response, and long-term outcomes of children diagnosed with ADHD. The wealth of information generated in the past few decades has been fundamental to the development of clear diagnostic criteria and the elucidation of the negative outcomes associated with ADHD. However, because a substantial portion of the extant knowledge has been informed by the repeated-assessment of clinically-referred males with ADHD, concern about the nature and degree to which these findings suffer from gender- and referral-bias is warranted.

The relative dearth of research on the manifestations and development of ADHD in girls most likely transpires from their comparatively lower rates of disruptive behaviors in early and middle childhood (Crick & Zahn-Waxler, 2003). Indeed, epidemiological studies have described a consistent three to one male-female ratio in prevalence rates of ADHD (Arnold, 1996; Barkley, 2002; Gaub & Carlson, 1997). There are even fewer girls in clinical settings, where ADHD-diagnosed boys outnumber ADHD-diagnosed girls ten to one (Gaub & Carlson, 1997). This may be due, in part, to the fact that girls are more likely to show the predominantly inattentive subtype of ADHD, which is relatively less disruptive than either the combined or hyperactive-impulsive subtypes (Arnold, 1996; Biederman, 1999; Gaub & Carlson, 1997). Thus, in comparison to their conventionally overactive male counterparts, girls' behaviors are likely to be under-recognized and/or neglected by both teachers and parents. It is possible, therefore, that the examination of girls with ADHD has been stymied by the lack of concern from parents and teachers and girls' minimal representation in clinic settings, the major recruitment site for clinical studies. However, in light of evidence that clinically significant ADHD can be identified in girls and the fact that girls appear to show a distinctive pattern of HIA symptoms, researchers have recently acknowledged the need to address the dearth of knowledge on ADHD in females (Arnold, 1996; Gaub & Carlson, 1997).

The next portion of this paper will review the data that have been gathered on girls with ADHD. As the early research on this topic concentrated on gender differences, I will begin by summarizing key findings in this area. However, more recently, researchers have begun to appreciate the need to study girls independently of boys. Findings from these investigations will be reviewed next. Finally, I will suggest some directions for future research on ADHD symptoms in girls.

## 1.1    MIXED-GENDER STUDIES OF ADHD

In an attempt to better understand gender differences in the behavioral style and associated functioning of ADHD-diagnosed children, Gaub and Carlson (1997) performed a meta-analysis on eighteen studies conducted between 1979 and 1992.  Their inclusion criteria demanded a sample size of at least ten and a Full Scale IQ of at least 70.  In comparison to boys, there was significant variation in the behavioral expression and functional impairment of girls.  Although ADHD-diagnosed girls in mental health settings suffered from the same noteworthy impairments as ADHD-diagnosed boys, ADHD girls identified in the community appeared to differ from boys recruited from non-clinical settings.  Varying prevalence rates and behavior patterns of girls according to setting suggests that, although very similar to boys in the clinic setting, 'genuine' gender differences exist in the general population of ADHD-diagnosed children.  For example, girls with ADHD identified in community settings appear to be less inattentive, less likely to have comorbid internalizing problems, and less impaired by their HIA behaviors than nonreferred boys showing ADHD symptoms (Gaub & Carlson, 1997).  Although compelling, Gaub and Carlson (1997) stressed the need for further research because (1) the studies differed in their assessment strategies (*DSM-II* through *DSM-III-R*) and the variables they investigated, and (2) the effect sizes were exceptionally small, suggesting that these findings may have little relevance.  They concluded their discussion by noting the need for studies with larger samples in order to ensure enough statistical power to accurately examine gender-differences in ADHD. The Multimodal Treatment Study of Children with ADHD (MTA; MTA Cooperative Group, 1999) was the first mixed-gender study to incorporate a large enough female sample (n=116) to validly inspect gender-specific manifestations of ADHD.  The six-site, MTA study was launched by the National Institute of Mental Health (NIMH) in the mid-90s to determine empirically the

most effective treatments for ADHD (MTA Cooperative Group, 1999). Although the rigorous 14-month treatment protocol (medication, behavioral, medication + behavioral, and community referral), administered to the 579 7-9 year old participants precludes the study of gender differences in the developmental course of ADHD, abundant data were collected prior to treatment (Abikoff, 2002). These baseline measures have allowed the investigators to examine gender differences in the manifestations of ADHD in the early elementary years (Abikoff et al., 2002; Newcorn et al., 2001).

The MTA Study team has published several findings indicating that symptoms of ADHD do vary by gender. For example, girls have lower levels of HIA behaviors than boys according to both teacher-ratings and the continuous performance test (CPT) (Newcorn et al., 2001). Observational measures of classroom behavior illustrated additional gender differences; girls with ADHD did not differ significantly from the comparison girls in their time away from their seat, physical aggression towards their peers, or verbal aggression with their teacher, whereas the boys with ADHD did (Abikoff et al., 2002). Furthermore, ADHD-diagnosed girls were less likely to break rules and interfere with classroom activities than the boys with ADHD (Abikoff et al., 2002). Thus, it appears that girls with ADHD show lower levels of HIA behavior and are less disruptive than boys with ADHD. Moreover, they appear to have acquired more social "knowledge" of what is and is not appropriate classroom behavior.

Although the MTA study includes the largest female sample in a mixed-gender design, several features of their sample precluded the examination of gender differences in either the expression or developmental course of HIA behaviors. First, all the participants were drawn from clinics, thus referral-bias could account for some of their findings. Secondly, the investigators included only children diagnosed with the combined subtype of ADHD, and thus

little is known about the behavior patterns shown by girls with the inattentive or hyperactive-impulsive subtypes. Given the widely endorsed hypothesis that girls may be more likely to display the inattentive subtype, further investigation is necessary. Finally, because the MTA Study is an intervention study, the developmental course of HIA behaviors could not be examined.

## 1.2    FEMALE SAMPLES OF ADHD CHILDREN

Investigators participating in an NIMH sponsored Conference on Sex Differences in ADHD suggested that "the expression, course, prognosis, and psychosocial treatment response in females as such deserves investigation in its own right, not just in terms of differences from males" (Arnold, 1996; pg.6). This is important because of the biological and social experiences unique to females that may influence their overall development. Thus, the manifestation and development of ADHD in females may be entirely different from what is normally observed in males. For example, evidence suggests that females may be socialized to internalize their problematic behaviors (Keenan & Shaw, 1994). An initially high level of hyperactive-impulsive behavior in girls may decrease across early development, despite continuing problems with inattention. The inattention may then fail to alert teachers to any problems with a girl's functioning because of its 'quiet' nature. Furthermore, as girls are likely to be physically, mentally, and emotionally more advanced than boys upon school entry, it is not known how HIA behaviors may interfere with their functioning at home, at school, and with peers. For example, girls with ADHD may develop fewer social and behavior problems in school, with friends, or in their family. On the other hand, their diagnosis may indicate that they are even more vulnerable

to developing problems in multiple domains of functioning than boys. This is a trend observed in another male-dominated disorder: conduct disorder (Keenan et al., 1999). Girls with conduct disorder appear to be more psychiatrically impaired and to have worse prognoses than boys with conduct disorder (Keenan, Loeber, & Green, 1999).

In the decade since the NIMH Conference, two landmark studies have been published on the manifestations of ADHD in females (Biederman et al.,1999; Hinshaw, 2002). The Biederman et al. (1999) sample is comprised of 140 clinically-referred females who were between the ages of 6 and 17 at baseline assessment. The participants were from middle- to upper-class Caucasian families. Hinshaw's sample is comprised of 140 girls recruited largely from pediatric and mental health settings. They were aged 6 – 12 at the baseline assessment and were both ethnically and socio-economically diverse. Both studies also included non-ADHD diagnosed comparison girls. These two studies are the first to investigate girls independently of boys, using large enough samples to permit valid statistical analysis. They also shared some overlap in age range, although the Biederman et al. sample was not separated into a younger and older cohort.

The data from the two studies suggest that inattention is especially salient in girls. Biederman and colleagues (1999) found that, regardless of ADHD subtype, girls with ADHD systematically exhibited more inattentive than hyperactive or impulsive features. Thus, girls who met diagnostic criteria for both the inattentive and hyperactive-impulsive subtype of ADHD (combined type) still exhibited higher levels of inattentive behaviors than hyperactive-impulsive behaviors. Hinshaw (2002) reported that rates of inattention were equivalent across both subtypes. Biederman and colleagues suggest that girls with a diagnosis of the combined subtype suffer mostly from inattention problems. Hinshaw's description indicates that although girls

with the combined subtype share similar rates of inattention with predominantly inattentive girls, they should still be characterized as overactive as well. Although it is difficult to ascertain the degree to which the reported findings corroborate or conflict with each other, information from both studies suggests that girls diagnosed with the combined subtype suffer from high levels of symptoms in both domains. Although this may be a redundant observation, it still needs to be made to support later analyses of the nature and extent of subtype differences.

These two investigations also examined the girls' functioning in a number of domains in which boys appear to be quite impaired. These include psychiatric morbidity, social functioning, academic achievement, cognitive abilities, and family relations. In regard to psychiatric functioning, Biederman and colleagues (1999) reported that although more likely to have comorbid problems than the comparison sample, girls with ADHD showed relatively lower rates of comorbid internalizing and externalizing problems than would be expected from boys with ADHD. Moreover, the girls did not vary across subtype in terms of the nature of comorbid diagnosis (i.e., internalizing vs. externalizing). In contrast to the Biederman et al. sample, rates of comorbid internalizing and externalizing problems varied by subtype in the Hinshaw (2002) sample. Although comparable to the inattentive subtype on anxiety and mood problems, girls with the combined subtype were significantly more likely to also receive comorbid diagnoses of oppositional defiant disorder (ODD) and conduct disorder (CD). These rates (71% ODD, 26% CD) surpassed rates that have been reported in previous observational studies of boys (Hinshaw, 2002). The findings from Hinshaw's sample (2002) suggest that girls with the combined subtype of ADHD suffer from other comorbid disruptive behavior problems, which is inconsistent with their significantly lower rates of referral in comparison to their male counterparts. A central rationale for why girls are less frequently diagnosed is that they are less disruptive, yet, the girls

in the Hinshaw study were even more disruptive than boys. This raises the question of whether girls' disruptive behavior is being ignored in the classroom and at home, or is being over-reported by adults who are less tolerant of these behaviors in girls.

ADHD status in general was associated with impaired social functioning across a broad range of behaviors and contexts. For example, girls with ADHD in the Biederman et al. sample (1999) were reported by parents to be showing higher rates of interpersonal difficulties with parents, siblings, teachers, and peers than control girls (Greene et al., 2001). Similarly, during a six-week camp, in which the participants completed sociometric measures on two occasions, ADHD girls in the Hinshaw sample were more often rejected than were their non-ADHD peers. In regard to the specific subtypes, the inattentive girls were more isolated, whereas the girls with the combined subtype were more rejected. Both types of ADHD girls also had more difficulty maintaining friendships. Although their friendships also included positive features, ADHD girls had more instances of conflict and relational aggression in their peer relationships than the comparison sample (Blachman & Hinshaw, 2002). Specifically, girls with the combined subtype were more relationally aggressive, whereas the girls with the inattentive subtype were more socially withdrawn than were the control girls (Hinshaw, 2002). The peer ratings of lower sociometric status and poorer peer and self-reported friendship quality nicely corroborate the findings of poorer social relationships from the Biederman et al. study. Moreover, these findings may suggest different patterns of impairment according to subtype, i.e. girls with the inattentive subtype may be more withdrawn and internalizing, whereas the girls with the combined subtype may be more socially and physically aggressive.

ADHD girls in both samples were more likely to receive special education placement and to have repeated a grade (Biederman et al., 1999; Hinshaw, 2002) than their non-ADHD

counterparts.  Girls with ADHD were also likely to have lower Full Scale IQ scores than non-ADHD diagnosed girls (Biederman et al., 1999; Hinshaw 2002).  They were also more likely than comparison girls to live in authoritarian family environments marked by high conflict, elevated rates of expressed emotion, and low cohesion (Biederman, 1999; Hinshaw, 2002, Peris & Hinshaw, 2003).

Hinshaw, Owens, Sami, and Fargeon (2006) conducted a five-year follow-up assessment on the girls in their sample (92% retention).  Their analyses were aimed both at understanding functioning at the time of follow-up and change in functioning across development.  At the time of follow-up, girls with both the combined and predominantly inattentive subtypes of ADHD continued to exhibit more ADHD symptomatology, externalizing problems, internalizing problems, social skills deficits academic underachievement, and school problems than the comparison girls.  In regard to change across time, girls with ADHD improved in functioning over the five years, on all measures except for math achievement, whereas the comparison girls showed an increase in TRF internalizing problems.  In terms of diagnostic retention, 24% of the girls classified as predominantly inattentive no longer received an ADHD diagnosis at follow-up, whereas 34% of the girls classified in the combined subtype category did not receive an ADHD diagnosis.  Five percent of the comparison girls exhibited diagnostic levels of inattention at follow-up.

Although these studies are the first comprehensive examinations of ADHD in girls, they are limited in the generalizability of their findings for several reasons.  First and foremost, conventional wisdom dictates that the psychopathology is likely to be more severe in mental health settings than in community settings (Costello, 1993).  As both of these studies recruited their participants from clinical or pediatric settings, it is impossible to determine the extent to

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which this referral bias has influenced the external validity of their reports.  The meta-analysis of the behavior patterns and functioning of ADHD-diagnosed females in both clinical and non-clinical settings certainly indicates the possibility of such a bias (Gaub & Carlson, 1997).  For example, the findings from the meta-analysis would suggest that the significant impairment demonstrated by the girls in these clinical samples may not be replicated in a community sample of girls with ADHD.

A limitation of the Biederman et al. (1999) study is its inability to shed light on the developmental course and long-term outcomes associated with ADHD symptoms.  Although the broad age span of their sample (age 6 -17) allows Biederman and colleagues to investigate possible age trends, they cannot elucidate the pattern of development within individuals across time.  Hinshaw and colleagues' follow-up study (2006) indicated that the girls diagnosed with ADHD at the baseline assessment continued to demonstrate impairment in multiple domains of functioning relative to the comparison sample, despite a number of girls falling out of diagnostic range.  An interesting finding was that the girls with ADHD seemed to improve a little as they developed, whereas the comparison group worsened to some degree (Hinshaw et al., 2006).  This suggests that ADHD-related impairment could be more marked in preadolescence, or it could be a statistical phenomenon, i.e., regression to the mean.  Further information on levels of symptomatology as they are related to impairment is needed, but Hinshaw and colleagues did not examine how age is related to changes in symptomatology and impairment.  Although they statistically controlled for cohort and age effects between the groups in order to ensure stringent research findings, this procedure did not allow them to elaborate on how ADHD may vary with age.  Despite the finding that some girls dropped out of diagnostic range and, in some cases, switched subtypes, it is not clear to which age-groups these girls belonged.  Thus, little is known

about the relative stability of inattentive and hyperactive-impulsive symptoms in girls. Finally, the predominantly middle- to upper-class and Caucasian nature of Biederman et al.'s sample patently limits the generalizability of his data. Although Hinshaw's sample was ethnically diverse, other limitations, as noted, prevent a thorough investigation of manifestations of ADHD in females.

In summary, preliminary findings from the first systematic investigations of the expression of ADHD in girls indicate that girls diagnosed with ADHD may be more likely to express inattentive, rather than hyperactive-impulsive symptoms, even when they meet diagnostic criteria for the combined subtype. Although there is some evidence that girls with ADHD are likely to be diagnosed with additional internalizing and externalizing disorders, the nature and degree of psychiatric impairment still requires clarification. While the MTA Study findings suggest that overactive girls are less disruptive in the classroom, indicating the acquisition of context-specific socially appropriate behavior, other clinical samples provide evidence of social dysfunction in the context of interpersonal relations (Biederman et al., 1999; Hinshaw, 2002; Blachman & Hinshaw, 2002). Girls with ADHD also appear to suffer from marked cognitive and academic impairment (Biederman et al., 1999; Hinshaw, 2002). However, given the referred and primarily cross-sectional nature of these samples, a community-based, longitudinal design is needed to examine the behavioral expression of HIA symptoms over time in females.

## 1.3    FUTURE DIRECTIONS

There are four issues that should be addressed in future research. The first involves the need to study the ADHD phenomenon in girls recruited from nonreferred settings. The second addresses the need to conduct longitudinal research in order to (1) model developmental pathways of ADHD symptoms and (2) understand how these symptom pathways are associated with outcomes. The third issue concerns the need to investigate dimensions of ADHD symptoms, rather than categories of problems in girls. Fourth, the appropriateness of using a person-centered statistical analysis to model ADHD behavior across time in girls is discussed.

Population-based samples are considered the best means for assessing the prevalence and normative expression of childhood problems because clinically referred children tend to present with the most severe forms of psychopathology (Costello, 1990). Given the disparate male-to-female ratios reported in clinical and nonreferred community settings (10:1 vs. 3:1), there is some indication that girls with ADHD in mental health settings may not be comparable to the girls who meet diagnostic criteria, but are not referred for assessment (Gaub & Carlson, 1997).

Psychopathology during childhood is best conceptualized as a "developmental deviation" rather than a "static" disorder (Cummings et al., 2000). As such, disordered behavior is characterized by more severe, extensive, and persistent expressions of otherwise normative behavior. The importance of examining behavior across both contexts and time necessitates the use of longitudinal designs. Although cross-sectional studies can assess age trends in the expression of various behaviors, it is impossible to determine the developmental course, i.e., continuity and discontinuity, of behaviors in this fashion. This is because two individuals demonstrating similar levels of behavior at one time point may or may not share the same developmental history (equifinality). Likewise, these same two individuals may not continue to

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show the same levels of behavior over the course of development (multifinality). The best example of this phenomenon is Moffit's model (1993) of the development of aggression. She identifies two pathways of aggressive behavior: childhood-onset and adolescent-limited (Moffitt, 1993). Each of these pathways is associated with different ages of onset, underlying mechanisms, and outcomes. Thus, two adolescents showing similar rates of aggression at age 14 may or may not also share the same age of onset, etiology, and later outcome. Therefore, it is important to follow the same individual across time in order to fully understand the stability and continuity of behaviors across development.

The majority of research on the development of ADHD has focused on the functioning of adolescents and adults who were first assessed and diagnosed with ADHD during their childhood (*developmental outcome studies*) (Willoughby, 2003). Although these studies reveal that children with ADHD are more likely than their peers to suffer from such detrimental outcomes as poor relations with their parents (Barkley, Fischer, Edelbrock, & Smallish, 1991; Klein & Manuzza, 1991), social dysfunction (Clark, Prior, & Kinsella, 2002; Hinshaw & Melnick, 1995), mood and anxiety disorders (Jensen, Shervette, Xenakis, & Richters, 1993; Treuting & Hinshaw, 2001), academic underachievement (Hinshaw, 1992), and antisocial behavior (Barkley, Fischer, Smallish, & Fletcher, 2004; Loeber et al., 1992), they frequently do not address the continuity/discontinuity of HIA behaviors as well (*developmental course studies*) (Willoughby, 2003). Elucidating the developmental course of HIA behaviors is critical for understanding *how* these behaviors impact functioning across age. For example, some children continue to express high levels of HIA behavior throughout adolescence and adulthood, whereas for others problem behaviors remit in mid-adolescence (Willoughby, 2003). Are those whose problem behaviors

remit more or less functional than those who continue to demonstrate high levels of problem behavior?

Another reason to examine the association between patterns of symptomatic behavior over time and later functioning is the possibility that the behavior may demonstrate *heterotypic* development (Willoughby, 2003). Heterotypic development occurs when a behavior manifests itself differently across the lifespan. Aggressive behavior is a common example of heterotypic development (Loeber et al., 1992) – kicking and biting in childhood and property destruction in adolescence are each a form of overt aggression. There is, therefore, a 'developmental sequence' to aggression. These findings suggest that if a hyperactive-impulsive behavior such as 'runs about and climbs excessively' disappears, it does not necessarily mean that the cause of 'runs about and climbs excessively' has also disappeared. It could be that the individual now 'touches and plays with novel objects', suggesting that the 'construct' is still in tact, although the behaviors that define it have changed (Willoughby, 2003). Thus, the current diagnostic criteria for ADHD appear to lack developmental sensitivity (Barkley, 2002).

The failure to consider the developmental continuity of HIA behavior, per se, has proven to be a problem in the study of the developmental course of ADHD because most longitudinal studies examine its course by assessing the rate of diagnostic retention at follow-up assessments during adolescence (Hill & Schoener, 1996; Willoughby, 2003). Although categorical diagnostic status is key for investigating group differences between ADHD diagnosed and comparison children, utilizing dimensional measurements (i.e., symptom counts) is a better means of inspecting the longitudinal patterns of symptoms. Moreover, because diagnostic criteria were developed on samples comprised almost exclusively of boys, one should not assume that they are "equally applicable" to boys and girls or to children of different ages (Willoughby, 2003; pg. 92).

This assumption might lead to the potential under-recognition of either heterotypic continuity or clinically significant types of ADHD in populations such as females.

There exist only a few studies chronicling the development of ADHD symptoms across childhood and adolescence. The foremost study yet to be published was conducted by Hart and colleagues on boys participating in the Developmental Trends Study (Hart et al., 1995). The investigators examined the developmental course of ADHD symptoms from age eight to age 15. They discovered that while hyperactive-impulsive symptoms declined across development, inattentive symptoms did not (Hart et al., 1995). Biederman and colleagues (2000) found that hyperactive, impulsive, and inattentive symptoms decline from age six to age 20. Although helpful for the literature, both of these studies utilized referred populations of males. Thus, referral-bias, once again, prevents the generalizability of these findings. Moreover, the individuals in these studies did not provide data for each age; the investigators used a cross-sectional, prospective design to determine the association between symptom expression and age. Cohort effects, therefore, still limit the interpretation of these studies. Another limitation to consider is the sole reliance on variable-centered methods of statistical analysis.

It is common practice for researchers to employ variable-centered designs and to compare clinical and non-clinical groups; however, in the case of heterogeneous disorders, such as ADHD, it may be more helpful to utilize person-centered techniques to "identify meaningful subgroups within a population that follow distinctive developmental trajectories" (Nagin, 2005, pg. 1). This approach may be particularly important in the study of ADHD because it has the potential to identify groups of children showing hyperactive-impulsive and inattentive behaviors that emerge at various times and levels of severity, allowing one to track changes in these behaviors across time. Shaw, Lacourse, and Nagin (2005) were modeled the developmental

course of ADHD symptoms with this method of analysis. Using a semi-parametric mixture model developed by Nagin (2005), Shaw and colleagues modeled the development of ADHD symptoms from ages two to 10 (Shaw et al., 2005). Their sample of low-income children were classified into four developmental trajectories: low (5.7%), moderate desister (26.9%), moderate stable (47.3%), and chronic (20%). Because the primary focus of this paper was the comparison of the trajectories of conduct problems and ADHD symptoms, the investigators did not compare these four groups on measures of functioning in other domains. Rather, they compared children on their combined conduct problems and ADHD symptoms status. Moreover, they did not separate the ADHD symptoms into the requisite hyperactive-impulsive and inattentive dimensions. Thus, it was difficult to ascertain the continuity of these two types of ADHD symptoms, which have already been shown to follow different developmental trajectories (e.g., Biederman et al., 2000; Hart et al., 1995). Another limitation to this study was its use of a male-only, high-risk sample, which is not representative of the general population. Nonetheless, this study revealed that there are different subgroups within the population showing different developmental patterns of ADHD symptoms. Thus, it would be advisable to continue to use statistical methods of analysis that model trajectories of hyperactive-impulsive and inattentive symptoms, thereby producing information on symptom heterogeneity. After identifying specific behavioral trajectories, one could then examine how membership within these trajectory groups is related to developmental outcomes in key domains of functioning.

# 2.0    THE PRESENT STUDY


Understanding the manifestations and development of HIA behaviors in females is a principal

concern for researchers today.    Although several studies have examined the behavioral

expression and functioning of girls with ADHD, these studies are limited by referral bias and by

cross-sectional designs.    A large, population-based sample studied using a prospective,

longitudinal design would be the next logical step in understanding the behavioral profiles of

ADHD symptoms in girls.    A fundamental part of this examination would entail the use of

dimensional scores, instead of diagnostic categories, in order to avoid the under-recognition of

clinically-relevant levels of behavior.    Finally, it would be beneficial to utilize a person-

centered, rather than variable-centered, approach to statistical analysis so as to identify and

model behavior patterns of "meaningful" subgroups within the sample.    Once distinct behavior

patterns, or trajectories, are ascertained, traditional methods of analysis can be used to determine

the extent to which children classified into distinct trajectory groups differ from one another on

relevant outcome measures.

The primary goal of the current study, therefore, was to use such a design to gain further

insight into the manifestations and development of HIA behaviors in girls.  This study utilized

data collected on a large, population-based sample of girls participating in a prospective,

longitudinal study.  A semi-parametric mixture modeling approach developed by Nagin and

colleagues (Nagin, 1999; 2005) was used to model trajectories of mother-rated HIA behavior

between kindergarten and fifth grade. As HIA behaviors are frequently conceptualized as being primarily inattentive or hyperactive-impulsive, these two dimensions of behavior were analyzed separately. However, because little is known about how these dimensions of behavior are associated with one another longitudinally, a dual trajectory method of analysis was used to evaluate the extent to which these dimensions are or are not related. Once trajectory groups were identified, they were compared on measures of academic, social, emotional, and behavioral functioning assessed in fifth and sixth grade.

# 3.0    HYPOTHESES

## 3.1    TRAJECTORIES OF HYPERACTIVE-IMPULSIVE BEHAVIOR FROM KINDERGARTEN TO FIFTH GRADE

Based on evidence from studies of the continuity of hyperactive-impulsive behavior in boys, it was hypothesized that at least three trajectories of hyperactive-impulsive behavior would emerge from the data.  It was expected that although there would be a small percentage of girls who maintain high levels of hyperactive-impulsive behavior across all time-points, the majority would manifest decreasing levels of hyperactive-impulsive behavior from kindergarten to fifth grade.  In addition, it was expected that a subgroup of girls who exhibit little to no hyperactive-impulsive behavior at any time-point would be identified.

## 3.2    2A. TRAJECTORIES OF INATTENTIVE BEHAVIOR FROM KINDERGARTEN TO FIFTH GRADE

Based on evidence from studies of the continuity of inattentive behavior in boys, it was hypothesized that at least three trajectories of inattentive behavior would emerge from the data. It was expected that there would be a subgroup of girls manifesting high and persistent levels of inattentive behavior from kindergarten to fifth grade and another that would exhibit little to no

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inattentive behavior across this time period. A third group exhibiting increasing or decreasing levels of inattention may also be identified. In addition, it was hypothesized that the low and high trajectories would demonstrate relative stability across time.

## 3.3    3A. JOINT TRAJECTORIES OF HYPERACTIVE-IMPULSIVE AND INATTENTIVE BEHAVIOR

It was hypothesized that girls assigned to trajectories characterized by high and persistent rates of hyperactive-impulsive behavior would most likely also be assigned to trajectories defined by high and persistent rates of inattentive behavior. On the other hand, girls assigned to the trajectories characterized by high and persistent rates of inattentive behavior would be just as, likely to be assigned to trajectories defined by low levels of hyperactive-impulsive behavior as to trajectories defined by high levels of hyperactive-impulsive behavior. It was also expected that the majority of girls would be most likely to manifest low levels of both inattentive behavior and hyperactive-impulsive behavior.

## 3.4    3B. FIFTH AND SIXTH GRADE CHILD OUTCOMES ASSOCIATED WITH JOINT TRAJECTORIES OF HYPERACTIVE-IMPULSIVE AND INATTENTIVE BEHAVIOR

It was hypothesized that girls classified in the highest and most persistent inattentive and hyperactive-impulsive trajectories would perform more poorly on all outcome measures than

girls who were classified in any other dual-trajectory group. It was also expected that girls expressing high levels of inattentive behavior only would perform more poorly on social, emotional, and academic outcome measures than girls who demonstrating low levels of both inattentive and hyperactive-impulsive behavior.

# 4.0    METHOD

## 4.1    PARTICIPANTS

This study used data collected from the female subset of a sample recruited in 1990 and 1991 to participate in the on-going, multi-site, NICHD Study of Early Child Care and Youth Development.  Healthy newborn babies and their families were recruited from hospitals located near the ten primary data collection sites across the US: Little Rock, AR; Irvine, CA; Lawrence, KS; Boston, MA; Philadelphia, PA; Pittsburgh, PA; Charlottesville, VA; Morganton, NC; Seattle, WA; and Madison, WI.  The analyses for this study will be based upon information gathered from the participants between kindergarten and sixth grade.

A total of 1, 364 families were recruited into the study from an original sample of 8, 986 mothers who were screened for study eligibility shortly after their child's birth.  Enrollment was determined by the following criteria: the mother was over 18 years of age, the mother was conversant in English, the family did not plan to move, the child was not hospitalized for more than seven days and did not have obvious disabilities after birth, the child was not from a multiple birth, the mother did not have a known or acknowledged substance abuse problem,  the family lived within an hour of the research site in a safe neighborhood, and the mother completed a home interview when the infant was one month old.  The final sample was diverse,

including 24% ethnic minority children, 11% mothers without a high school education, and 14% single parent households.

Out of the 1, 364 participants constituting the original sample, a total of 659 were female. Children from this subset of the NICHD sample were included in the study if they had HIA behavior ratings for a least two out of six time-points (N=550).

Attrition analyses, comparing the female participants who were not included in the trajectory analyses (N=109) due to insufficient data with those who met the above criteria (N=550), revealed significant differences between the groups.  Data collected at the one month home visit indicate that the girls included in this study have more highly educated mothers (M=14.52 vs. 13.33 years of education, F= 20.93, p=.000), and live in families with higher income-to-needs ratios (M=2.99 vs. 1.83, F=14.28, p=.000).  Thus, the sample for the current study is biased towards more educated and affluent backgrounds.


## 4.2    PROCEDURE


Demographic information, such as maternal education level, mother's marital status, family composition, and family's income-to-needs ratio (total annual family income divided by the poverty threshold for the family's size), was collected at regular intervals beginning when the children were one month old.  Child ethnicity was also recorded at this time. During these home interviews, the primary caregiver also completed multiple questionnaires assessing their child's performance in various domains of functioning.  HIA behaviors were assessed with the Child Behavior Checklist (CBCL 4/18; Achenbach, 1991a) when the children were in kindergarten, first grade, third grade, fourth grade, fifth grade, and sixth grade.

At fifth and sixth grade teachers completed a number of standard measures of children's behaviors in the classroom and with peers.  These included the Teacher Report Form (TRF; Achenbach, 1991b), Disruptive Behavior Disorders Questionnaire (DBD; Pelham, Gnagy, Greenslade, & Milich, 1992), and the Social Skills Rating System (SSRS; Gresham & Elliott, 1990).

Children completed questionnaires during home and lab visits in fifth and sixth grade. These included the Loneliness and Social Dissatisfaction Questionnaire (LSDQ; Asher, Hymel, & Renshaw, 1984), the Friendship Quality Questionnaire (FQQ; Parker & Asher, 1993), and the Children's Depression Inventory, Short Form (CDI; Kovacs, 1992).  They were also administered the Woodcock-Johnson Psycho-Educational Battery (Woodcock & Johnson, 1989, 1990), a measure of academic achievement, during a lab visit in fifth grade.  Table 1 contains a summary of all study measures and their administration schedule.

**Table 1 Study Measures and their Assessment Schedule**

| | K | 1st | 3rd | 4th | 5th | 6th |
|---|---|---|---|---|---|---|
| **HIA Behaviors** | | | | | | |
| CBCL[1] – Inattention/ Hyperactivity-Impulsivity | X | X | X | X | X | X |
| **Emotional Competence** | | | | | | |
| TRF[2] – Internalizing | | | | | *(X)[a]* | X |
| CDI[3] - Depression | | | | | X | |
| | | | | | X | |
| **Behavior Problems** | | | | | | |
| TRF – Externalizing | | | | | *(X)* | X |
| DBD[4] - ADHD Status | | | | | *(X)* | X |
| **Academic Achievement** | | | | | | |
| WJ-R[5] - Reading/Math | | | | | X | |
| **Social Competence** | | | | | | |
| SSRS[6] - Social Skills | | | | | *(X)* | X |
| CRP[7] - Victimized/Rejected Relational Aggression | | | | | X | |
| FQQ[8] - Friendship Quality | | | | | *(X)* | X |
| LDSQ[9] - Loneliness | | | | | X | |

[1] Child Behavior Checklist (CBCL)
[2] Teacher Report Form
[3] Child Depression Inventory – Short Form
[4] Disruptive Behavior Disorders Questionnaire
[5] Woodcock-Johnson Psycho-Educational Battery - Revised
[6] Social Skills Rating System
[7] Child Relations with Peers
[8] Friendship Quality Questionnaire
[9] Loneliness and Social Dissatisfaction

## 4.3 MEASURES

### 4.3.1 Demographics (Covariates)

#### 4.3.1.1 Maternal education:

The number of years in school completed at the time of recruitment was used as an index of maternal education.

#### 4.3.1.2 Average income-to-needs ratio:

Family income and size was recorded during home visits conducted regularly between age one month and fifth grade. Total household income including government payments was divided by the appropriate poverty threshold for that year based on household size (U.S. Department of Labor, 1994; NICHD Early Child Care Research Network, 1999). Income-to-needs ratios were averaged from third through sixth grade to create an index of each family's economic status. Scores of $\leq 2.0$ are indicative of poverty.

#### 4.3.1.3 Ethnicity:

For the purposes of this study, child ethnicity was scored as a dichotomous variable (White/Non-White).

#### 4.3.1.4 Family Composition:

Families were categorized as either a 'two parent' or 'other' household.

**4.3.2   HIA Behaviors**

**4.3.2.1 Child Behavior Checklist (CBCL; Achenbach, 1991a).**

The CBCL is a widely used measure of children's behavior.  The questionnaire contains 118 items presenting a broad range of behavioral and emotional problems that may be experienced by children.  Primary caregivers were asked to rate their children's behavior in the past six months on a three point scale (0 = not true, 1 = somewhat or sometimes true, and 3 = very or often true).  Four items from the Attention Problems subscale were used to generate a composite measure of inattentive behavior.  These items ('can't concentrate, can't pay attention', 'confused or seems to be in a fog', 'day-dreams or gets lost in her thoughts', 'stares blankly') were selected on the basis of their compatibility with diagnostic criteria for inattention listed in the DSM-IV (APA, 1994).  Cronbach's alphas range from .59 (kindergarten) to .65 (fifth grade). Likewise, four items from the Attention Problems subscale ('can't sit still, restless, or hyperactive', 'impulsive or acts without thinking', 'talks too much', 'unusually loud') were used to generate a hyperactive-impulsive composite. Cronbach's alphas range from .71 (fifth grade) to .73 (kindergarten).   The correlations between the hyperactive-impulsive and inattentive composite score at each time point ranged from 0.44 (kindergarten) to 0.55 (fourth grade).

**4.3.3   Child Outcome Measures**

**4.3.3.1 Teacher reports:**

(1) <u>Teacher reports of children's behavior problems:</u>   Teacher reports of children's behavior problems were assessed with the Teacher Report Form (TRF, Achenbach, 1991b). Scores on the TRF yield two broadband scales consisting of (a) *Internalizing Problems* (35

items, α = .87) and (b) *Externalizing Problems* (34 items, α = .95). Raw scores are converted into standard T-scores, based on normative data for children of the same age.

Using the Disruptive Behavior Disorders Questionnaire (DBD, Pelham, Gnagy, Greenslade, & Milich, 1992), teachers rated each child on the 26 specific ADHD and ODD symptoms listed in the DSM-IV (American Psychiatric Association, 1994). For each symptom, teachers were asked to rate whether the behavior was "not at all" (0), "sometimes" (1), "pretty much" (2), or "very much" (3) a problem for the child. These were summed to derive total symptom scores for ODD, hyperactive-impulsivity, and inattention.

(2) Teacher reports of social competence: Teachers completed the school version of the Social Skills Questionnaire from the Social Skills Rating System (SSRS, Gresham & Elliott, 1990) when the study girls were in fifth and grade. The total score is the sum of all 30 social competence items, with higher scores reflecting higher levels of perceived social competence. The SSQ was normed on a diverse, national sample of children and shows high levels of test-retest reliability (.75-.88). Internal consistency in the present sample is high (30 items, α = .94)

Teachers also completed a questionnaire designed to measure the child's peer-related behaviors in fifth and sixth grade. The Child Relationships with Peers questionnaire consists of 43 items derived from several other measures of positive and negative peer behavior, including bullying, exclusion, victimization, and prosocial behavior (Crick, Bigbee, & Howes, 1996; Ladd & Profilet, 1996). Children's behavior with peers was rated on a 3-point scale (0=true, 1=sometimes true, 2=often true). Principal components analysis of responses in the current sample yielded several internally consistent scales relevant to the current analyses that did not overlap in content with other teacher report measures such as the TRF and SSRS; *excluded* by

peers (4 items, alpha = .90), *victimized* by peers (7 items, alpha = .89), and uses *relational aggression* with peers (6 items, alpha=.86).

**4.3.3.2 Child Reports:**

(1) <u>Child reports of social competence:</u> Self-reported *loneliness* was assessed during the fifth grade home visit with the Loneliness and Social Dissatisfaction Questionnaire (LSDQ; Asher, Hymel, & Renshaw, 1984). The 16 loneliness items were rated on a 5-point scale (1=not at all true to 5=always true, alpha = .91), with higher scores reflecting greater feelings of loneliness.

During a sixth grade lab, children completed the 21-item Friendship Quality Questionnaire (FQQ; Parker & Asher, 1993), assessing children's views of their relationship with their best friend. Items are rated on a 5-point scale (1=not at all true to 5= really true). Twenty items make up the total *friendship quality* score (alpha=.87), with higher scores reflecting a more positive (validation, companionship, disclosure) and less negative (conflict) relationship.

(2) <u>Child report of depression:</u> At fifth and sixth grade, children completed ten-item measure of depressive symptoms experienced in the past two weeks (Children's Depression Inventory, Short Form, CDI; Kovacs, 1992). Ten sets of three statements were presented and the child selected the one that best described the way she felt over the last two weeks. Raw scores above 8 for girls are considered "well above average". Internal consistency for the current sample is moderate ($\alpha$= .76).

### 4.3.3.3 Academic Achievement

(1) The children were administered the Woodcock Johnson Psycho-Educational Battery during a lab visit in fifth grade.  This test generated a Broad Reading Standard Score (100 items, $\alpha = .91$) and the Broad Math Standard score (118 items, $\alpha = .91$).

# 5.0    DATA ANALYSIS

## 5.1    HYPOTHESES 1A AND 2A: ESTIMATING TRAJECTORIES OF HYPERACTIVE-IMPULSIVE AND INATTENTIVE BEHAVIOR

A semi-parametric group-based modeling approach developed by Nagin and colleagues (TRAJ; 2005) was utilized to identify the subgroups of individuals following specific trajectories of maternal-rated inattentive (Hypothesis 1a) and hyperactive-impulsive (Hypothesis 2a) behavior. Five data points (Kindergarten, $1^{st}$, $3^{rd}$, $4^{th}$, and $5^{th}$ grade) were used to model both the hyperactive-impulsive and inattentive developmental trajectories. The data at each time point were represented as a composite score, with values ranging between zero and eight. As TRAJ works well with missing data, cases were included if they had data for two or more time-points. The censored (scaled) nature of the data allowed for the trajectories to be estimated using the Censored Normal approach to modeling the data.

The statistical significance of the polynomial function parameters (i.e., cubic, quadratic, linear, or zero-order) was used to estimate the shape of each trajectory within each model tested (Nagin, 2005). The Bayesian Information Criterion (BIC) score was the principal means of selecting the best-fitting model for the data (Nagin, 2005). Most researchers select the model with the largest BIC value (i.e., closest to zero); however, the BIC is highly influenced by parsimony, and models with fewer groups tend to receive the highest scores. Thus, other features

of the model were considered before making a final selection. Another key criterion was the mean estimate of posterior probabilities of group membership for each trajectory group (Nagin, 2005). Each girl receives scores which are an estimate of the likelihood of belonging to each trajectory group within a given model, with the highest score corresponding to the group to which her behavior is most similar, and to which she is assigned, and the lowest estimate corresponding to the group to which her behavior is most dissimilar. Thus, as the model approaches its best fit to the data, the probability of belonging to the assigned group will approach 1 and the probability of belonging to other groups will approach 0. The mean estimate of posterior probabilities of group membership for each trajectory group, therefore, provides another means of ascertaining how well the trajectories describe the entire sample by considering *classification error*. A mean posterior probability score of at least 0.70 is considered adequate for model selection (Nagin, 2005).

## 5.2    HYPOTHESIS 3A: ESTIMATING JOINT TRAJECTORIES OF INATTENTIVE AND HYPERACTIVE-IMPULSIVE BEHAVIOR

It is possible to modify this group-based modeling approach to examine the association between developmental trajectories of inattentive and hyperactive-impulsive behavior (Hypothesis 3a) (Nagin & Tremblay, 2001; Nagin, 2005). The dual trajectory model uses the parameter estimates of the previously defined best-fit inattentive model and the best-fit hyperactive-impulsive model to calculate: (1) the trajectories for each behavior (inattentive and hyperactive-impulsive), (2) the trajectory group membership probabilities for each behavior, and (3) the probabilities of joint trajectory group membership across both models of behavior. The

probabilities of joint trajectory group membership across behaviors presented by this dual model are considered superior to a cross-tabulation because they provide a more coherent description of how the two behaviors overlap. TRAJ analysis generates three types of probabilities: (1) inattentive trajectory group membership probabilities conditional on hyperactive-impulsive trajectory group classification, (2) hyperactive-impulsive group membership probabilities conditional on inattentive trajectory group classification, and (3) joint probabilities of being in a specific inattentive trajectory and in a specific hyperactive-impulsive trajectory. Another feature of the dual model is the ability to classify an individual in a second model dependent on their classification in the first model entered into the statistical program. Thus, if the hyperactive-impulsive parameter estimates are entered first into the program, the TRAJ program uses these estimates, together with the inattentive parameter estimates and the posterior group probabilities, to classify individuals into the inattentive trajectory groups.

## 5.3 HYPOTHESES 1B, 2B, AND 3B: COMPARING CHILD OUTCOMES ON THE BASIS OF TRAJECTORY GROUP CLASSIFICATION

In order to maximize the number of individuals providing data for the outcomes analyses, mean scores of 5th and 6th grade functioning were obtained for all measures administered at both of these time points. In the case of missing data for either 5th (n=52) or 6th (n=46) grade measures, the data for just one time-point were used for outcomes analyses. The Loneliness Questionnaire and WJ-R were administered only at 5th grade (see Table 1). Intercorrelations among the outcomes measures are revealed in Table 2.

**Table 2 Intercorrelations Among Child Outcome Measures**

| Outcome Measure | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. DBD Hyperactive-Impulsive –T | - | | | | | | | | | | | | | |
| 2. DBD Inattentive – T | 0.52** | - | | | | | | | | | | | | |
| 3. DBD ODD – T | 0.72** | 0.57** | - | | | | | | | | | | | |
| 4. TRF Externalizing – T | 0.77** | 0.60** | 0.81** | - | | | | | | | | | | |
| 5. TRF Internalizing – T | 0.21** | 0.47** | 0.34** | 0.36** | - | | | | | | | | | |
| 6. TRF Attention Problems – T | 0.53** | 0.92** | 0.55** | 0.60** | 0.50** | - | | | | | | | | |
| 7. SSRS Total – T | -0.42** | -0.71** | -0.57** | -0.59** | -0.49** | -0.69** | - | | | | | | | |
| 8. CPR Prosocial – T | -0.39** | -0.47** | -0.58** | -0.53** | -0.29** | -0.48** | 0.69** | - | | | | | | |
| 9. CPR Peer Victimization – T | 0.47** | 0.55** | 0.52** | 0.52** | 0.38** | 0.52** | -0.48** | -0.40** | - | | | | | |
| 10. CPR Relational Aggression – T | 0.54** | 0.42** | 0.65** | 0.67** | 0.23** | 0.39** | -0.41** | -0.42** | 0.43** | - | | | | |
| 11. CDI Depression – C | 0.03 | 0.14** | 0.14** | 0.15** | 0.16** | 0.16** | -0.22** | -0.14** | 0.13** | 0.11* | - | | | |
| 12. LDSQ Loneliness – C | 0.10* | 0.23** | 0.19** | 0.21** | 0.15** | 0.25** | -0.31** | -0.26** | 0.22** | 0.09 | 0.59** | - | | |
| 13. FQQ Friendship Quality – C | -0.13** | -0.15** | -0.17** | -0.14** | -0.11* | -0.16** | 0.18** | 0.11* | -0.12** | -0.03 | -0.24** | -0.31** | - | |
| 14. WJR Math | -0.15** | -0.41** | -0.23** | -0.25** | -0.16** | -0.42** | 0.33** | 0.22** | -0.16** | -0.20** | -0.14** | -0.15** | 0.04 | - |
| 15. WJR Reading | -0.19** | -0.35** | -0.22** | -0.24** | -0.12* | -0.37** | 0.30** | 0.22** | -0.14** | -0.20** | -0.11* | -0.15** | 0.03 | 0.68** |

*Note.* The following measures provide a mean score of fifth and sixth grade functioning: Disruptive Behavior Disorders Questionnaire (DBD), Teacher Report Form (TRF),Child Depression Inventory (CDI), Social Skills Rating System (SSRS), Child Peer Relations (CPR), Friendship Quality Questionnaire (FQQ); the Loneliness and Dissatisfaction Questionnaire (LDSQ) and Woodcock-Johnson Psycho-Educational Battery – Revised (WJR) provide scores for fifth grade only;  T = teacher report, C = child report; ODD = oppositional defiant disorder.  * $p < .05$; ** $p < .01$

Outcome analyses were conducted in two ways, with weighted and unweighted scores. Because assignment to a given trajectory group is based upon a probability score, all of the follow-up analyses were first run using actual scores and then re-run with a weighted score reflecting this probability in order to ensure that the data were not inaccurately represented. The outcomes of these analyses were not significantly different from those run without the weighted score. The results presented below reflect the outcomes of the unweighted analyses.

Because of the possible confounding nature of particular background characteristics, the trajectory groups for each model (inattentive, hyperactive-impulsive, and joint) were compared on the following demographic variables: income-to-needs ratio (mean of income from 3rd through 6th grade), mother education, partner in household (yes/no), and child race (majority vs. minority). The demographic variables for which there were significant group differences were included as covariates in all subsequent analyses.

The outcome measures were considered to reflect six domains of functioning: HIA Behaviors, Externalizing Symptoms, Internalizing Symptoms, Social Skills, Peer Relationships, and Academic Achievement. A multivariate analysis of covariance (MANCOVA) was conducted on five of these six domains of functioning for each set of trajectories (inattentive, hyperactive-impulsive, and joint) (Hypotheses 1b, 2b, and 3b). The SSRS was the only measure in the Social Skills domain. When the trajectory group main effect was significant in the MANCOVA, follow-up analyses of covariance (ANCOVAs) were performed separately on each measure, with trajectory group as the independent variable. Bonferroni's post hoc comparisons were utilized when examining significant trajectory group differences to control for experiment-wise error.

# 6.0    RESULTS

The first section of the results presents the best-fitting trajectory models of hyperactive-impulsive and inattentive behaviors identified by TRAJ (Nagin, 2005).  The next section delineates the results from the dual trajectory analysis.  The subsequent three sections are devoted to the follow-up analyses associated with each trajectory model.

## 6.1    HYPOTHESES 1A AND 2A: ESTIMATING TRAJECTORIES OF HYPERACTIVE-IMPULSIVE AND INATTENTIVE BEHAVIOR

### 6.1.1   Hyperactive-Impulsive Trajectory Model

Table 3 compares the BIC scores, mean estimates of posterior probabilities of group membership, and observed/predicted N for various models that differ by trajectory group number.  Although the BIC score for a five-group solution is better than the BIC score for a four-group solution, the four-group model was selected as the best fit for the hyperactive-impulsivedata.  The four group model evidenced higher mean estimates of posterior probabilities of group membership.  In addition, the trajectories in the five group model were less clearly differentiated from one another, and the small number of girls in the highest trajectory group left less power for later analysis.

**Table 3 Bayesian Information Criterion (BIC), Observed and Predicted Group Size, and Mean Posterior Probability of Group Membership by Hyperactive-Impulsive Model Type**

| Model | Order[a] | BIC | Trajectory Group | Observed N | Predicted N | Mean Posterior Probability of Group Membership |
|-------|---------|------|------------------|------------|-------------|-----------------------------------------------|
| Three Group | 2 1 0 | -3873.83 | GRP 1 | 222 | 214 | 0.92 |
| | | | GRP 2 | 256 | 264 | 0.93 |
| | | | GRP 3 | 71 | 72 | 0.92 |
| Four Group | 2 1 0 0 | -3812.44 | GRP 1 | 135 | 133 | 0.92 |
| | | | GRP 2 | 226 | 230 | 0.88 |
| | | | GRP 3 | 148 | 146 | 0.88 |
| | | | GRP4 | 40 | 40 | 0.92 |
| Five Group | 2 1 0 0 0 | -3802.24 | GRP 1 | 125 | 125 | 0.91 |
| | | | GRP 2 | 213 | 209 | 0.86 |
| | | | GRP 3 | 140 | 144 | 0.84 |
| | | | GRP 4 | 54 | 53 | 0.82 |
| | | | GRP 5 | 17 | 17 | 0.91 |

[a] Entries in this column refer to the polynomial function parameters (i.e., quadratic (2), linear (1), or zero-order(0)) that were used to estimate the shape of each trajectory within each model tested.

Figure 1 presents the predicted and observed trajectories of hyperactive-impulsive behavior. The first group (24.6% of the sample) is defined by continuously very low levels of hyperactive-impulsive behavior ('very low'). The second group, comprising the majority of the sample (41.2%), is characterized by low levels of hyperactive-impulsive behavior ('low'). The third group (26.9% of the sample) demonstrates continuously moderate levels of hyperactive-impulsive behavior ('moderate'). The fourth group (7.3% of the sample) is characterized by chronically moderate levels of hyperactive-impulsive behavior ('high').
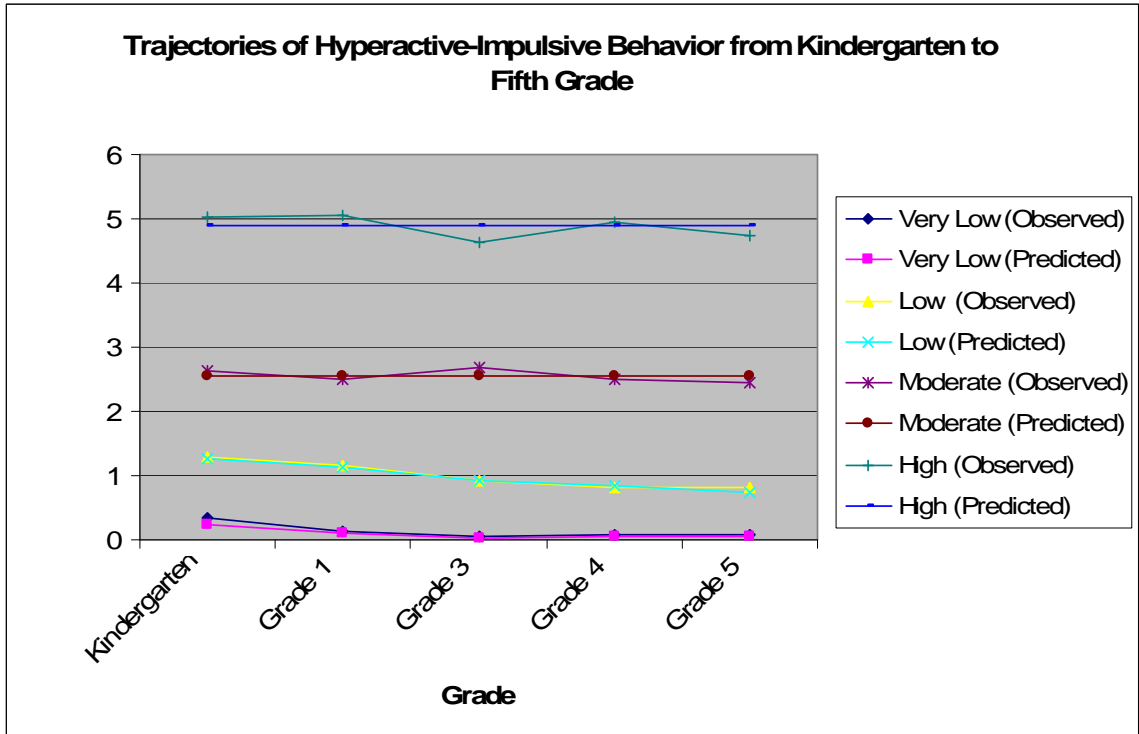
**Figure 1**

## 6.1.2 Inattentive Trajectory Model

Table 4 compares the BIC scores, mean estimates of posterior probabilities of group membership, and observed/predicted N for various models that differ by number of trajectory groups. As can be seen, a four-group model, characterized by two linear and two quadratic function trajectories, is the best fit for inattentive behavior.

**Table 4 Bayesian Information Criterion (BIC), Observed and Predicted Group Size, and Mean Posterior Probability of Group Membership by Inattentive Model Type**

| Model | Order[a] | BIC | Trajectory Group | Observed N | Predicted N | Mean Posterior Probability of Group Membership |
|---|---|---|---|---|---|---|
| Three Group | 1 2 2 | -3082.36 | GRP 1 | 265 | 265 | 0.93 |
| | | | GRP 2 | 242 | 238 | 0.90 |
| | | | GRP 3 | 42 | 46 | 0.90 |
| Four Group | 1 1 2 2 | -3073.45 | GRP 1 | 189 | 174 | 0.85 |
| | | | GRP 2 | 84 | 102 | 0.82 |
| | | | GRP 3 | 236 | 229 | 0.89 |
| | | | GRP4 | 40 | 44 | 0.91 |
| Five Group | 0 1 2 2 1 | -3077.34 | GRP 1 | 138 | 107 | 0.78 |
| | | | GRP 2 | 175 | 205 | 0.89 |
| | | | GRP 3 | 199 | 196 | 0.87 |
| | | | GRP 4 | 36 | 41 | 0.92 |
| | | | GRP 5 | 1 | 5 | 1.00 |

[a] Entries in this column refer to the polynomial function parameters (i.e., quadratic (2), linear (1), or zero-order(0)) that were used to estimate the shape of each trajectory within each model tested.

Figure 2 presents the observed and predicted trajectories of inattentive behavior. The first group, comprising 31.7% of the sample, is characterized by continuously very low levels of inattention ('very low'). The second group (18.6% of the sample) is defined by low, but decreasing levels of inattention ('low decreasing'). The third group contains the majority of the sample (41.8%) and describes stable levels of low inattention ('low stable'). The fourth group (8% of the sample) is defined by both increasing, moderate inattentive behavior ('moderate increasing').
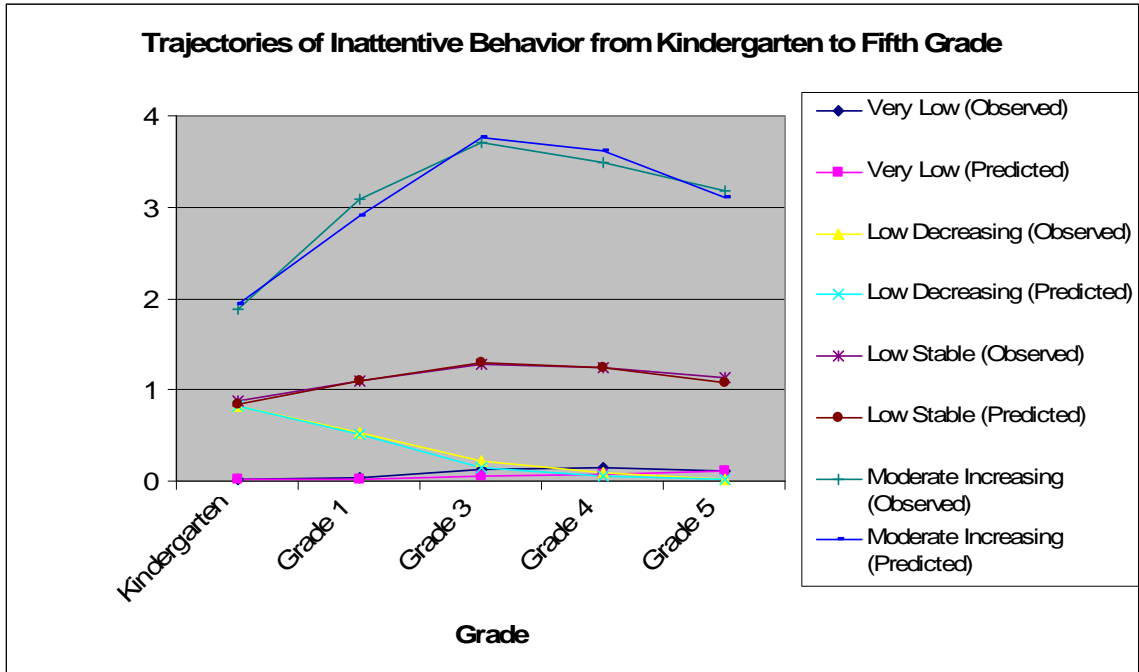
Figure 2

## 6.2 HYPOTHESIS 3A: JOINT TRAJECTORIES OF HYPERACTIVE-IMPULSIVE AND INATTENTIVE BEHAVIOR

As stated above, the dual model of trajectory analysis uses the parameter estimates from the two previously defined models of hyperactive-impulsive and inattentive behavior to re-calculate the two trajectory models. The trajectories identified in the two models retained the same shape and the proportion of girls in each trajectory group did not vary by more than 1.5%.

Table 5 presents the association between trajectories of hyperactive-impulsive and inattentive behavior. The first section of probabilities pertains to the likelihood of being classified in each inattentive group on the basis of hyperactive-impulsive trajectory group classification. For example, if an individual is assigned to the 'high' hyperactive-impulsive

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trajectory group, there is a 2.3% chance of being assigned to the 'very low' inattentive group, 0.0% chance of being assigned to the 'low decreasing group', 51.2% chance of being assigned to the 'low stable' group, and a 46.4% chance of being assigned to the 'moderate decreasing' group. As can be seen, if a girl is assigned to either the 'very low' or 'low' hyperactive-impulsive trajectory groups, she is most likely to also be classified in the 'very low', 'low decreasing', and 'low stable' inattentive trajectory groups. If a girl is assigned to the 'moderate' or 'high' hyperactive-impulsive trajectory group, she is most likely to be assigned to either the 'low stable' or 'moderate decreasing' inattentive trajectory groups.

The second section presents the likelihood of being classified in each hyperactive-impulsive trajectory group on the basis of inattentive trajectory group classification. Girls classified in the 'very low' and 'low decreasing' inattentive trajectory groups are most likely to be classified in the 'very low' and 'low' hyperactive-impulsive trajectory groups. Girls in the 'low stable' inattentive group are most likely to be assigned to the 'low' and 'moderate' hyperactive-impulsive trajectory groups. Girls in the 'moderate decreasing' inattentive group are most likely to be assigned to the 'moderate' and 'high' hyperactive-impulsive trajectory groups.

The third section of the table presents the unconditional probabilities of cross-group classification. As can be seen, there is a very small likelihood of a girl being classified in the 'high' hyperactive-impulsive trajectory group and also in the 'very low' (0.2%) or 'low decreasing' (0.0%) inattentive group. Girls are also extremely unlikely to be classified in the 'very low' hyperactive-impulsive trajectory group and the 'moderate decreasing' (0.2%) inattentive group. Girls are most likely to be classified in both a 'moderate' hyperactive-impulsive and 'low stable' inattentive group (18.3%). The second most likely cross-

classification is to the 'very low' hyperactive-impulsive and 'very low' inattentive groups (14.9%).

**Table 5 Joint Trajectories of Hyperactive-Impulsive and Inattentive Behavior**

| Group | Very Low | Low Decreasing | Low Stable | Moderate Increasing |
|---|---|---|---|---|
| Probability of inattentive group conditional on hyperactive-impulsive group | | | | |
| Very Low | .573 | .230 | .191 | .070 |
| Low | .344 | .258 | .358 | .039 |
| Moderate | .095 | .034 | .690 | .182 |
| High | .023 | 0 | .512 | .464 |
| | | | | |
| Probability of hyperactive-impulsive group conditional on inattentive group | | | | |
| Very Low | .474 | .346 | .120 | .018 |
| Low | .441 | .602 | .348 | .159 |
| Moderate | .080 | .052 | .443 | .487 |
| High | .005 | 0 | .089 | .335 |
| | | | | |
| Joint probability of inattentive group and hyperactive group | | | | |
| Very Low | .149 | .060 | .050 | .002 |
| Low | .138 | .104 | .144 | .016 |
| Moderate | .025 | .009 | .183 | .048 |
| High | .002 | 0 | .037 | .033 |

Another feature of the dual model of trajectory analysis is group assignment to the second model as a condition of the posterior group probabilities of the first and second models. As the parameters of the hyperactive-impulsive trajectory model were entered first into the statistical program, the classification to the inattentive group was based on the posterior group probabilities of both the hyperactive-impulsive and inattentive trajectories. Table 6 presents the cross-classifications of the participants based upon the dual model group assignments.

**Table 6 Cross-Classification of Inattentive and Hyperactive-Impulsive Trajectory Groups**

|  | Very Low | Low Decreasing | Low Stable | Moderate Increasing | *Total* |
|---|---|---|---|---|---|
| Very Low | 91 | 29 | 24 | 1 | *145* |
| Low | 83 | 46 | 86 | 8 | *223* |
| Moderate | 16 | 3 | 98 | 24 | *141* |
| High | 1 | 0 | 21 | 18 | *40* |
| *Total* | *191* | *78* | *229* | *51* | *549* |

*Note.* Columns represent inattentive trajectory groups, whereas rows represent hyperactive-impulsive trajectory groups.

## 6.3 HYPOTHESIS 1B: EXAMINING DEMOGRAPHIC AND OUTCOME MEASURES ON THE BASIS OF HYPERACTIVE-IMPULSIVE TRAJECTORY GROUP CLASSIFICATION

### 6.3.1 Demographics

Table 7 presents the descriptive and inferential statistics associated with the demographic measures as a function of trajectory group membership. ANOVAs on the income-to-needs ratio and mother education variables and Pearson chi-square tests on the household composition and child race variables indicated that there were, indeed, significant group differences on all demographic measures. Scheffé post hoc comparisons revealed that girls classified in the 'moderate' and 'high' hyperactive-impulsive trajectory groups come from families with significantly lower income-to-needs ratios and their mothers have fewer years of education than those of girls classified in the 'very low' and low' trajectories. As each of the demographic

variables demonstrated significant group differences, they were entered as covariates in the proceeding analyses.

**Table 7 Demographics by Hyperactive-Impulsive Trajectory Group Classification**

| | Very Low | | | Low | | | Moderate | | | High | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $n$ | $M$ | $SD$ | $N$ | $M$ | $SD$ | $n$ | $M$ | $SD$ | $n$ | $M$ | $SD$ | $F/\chi^2$ | $p$ |
| Demographics | | | | | | | | | | | | | | |
| Income-to-Needs Ratio – M | 132 | 5.9[a] | 4.3 | 219 | 4.8[a] | 4.0 | 144 | 3.6[b] | 2.7 | 39 | 2.7[b] | 2.3 | 13.03 | .000 |
| Mother Education – M | 133 | 15.3[a] | 2.2 | 230 | 14.7[a] | 2.6 | 146 | 13.9[b] | 2.2 | 40 | 13.2[b] | 2.4 | 13.07 | .000 |
| Partner in Household (y/n) (%) –M | 129 | 83.7 | | 215 | 74.9 | | 139 | 69.8 | | 38 | 57.9 | | 12.92 | .005 |
| Child Race: Majority (%) – M | 133 | 89.5 | | 230 | 80.4 | | 146 | 80.8 | | 40 | 62.5 | | 15.35 | .002 |

*Note.* M = maternal report.  Superscripts in each row differ significantly, as indicated by either Scheffé's post-hoc comparisons (continuous variables) or 2x2 chi-square tests (categorical variables).

### 6.3.2   HIA Behaviors

The MANCOVA performed on the measures for this domain was significant, Pillai's Trace = 0.090, $F(9, 1422)$ = 4.88, $p$ = .000.

Each of the follow-up univariate $F$-tests was statistically significant (see Table 8).  The post hoc comparisons indicated that teachers

rated girls in the 'very low' and 'low' groups as significantly less hyperactive-impulsive than the girls classified in the 'moderate' and 'high' groups.  Girls classified as 'very low' and 'low' were less inattentive than girls in the 'moderate' trajectory group on teacher ratings of inattention on the DBD, whereas only the 'very low' group differed significantly from the 'moderate' group on teacher ratings of attention problems on the TRF.  There were no significant differences between girls in the 'high' hyperactive-impulsive trajectory group and any of the other trajectory groups on teacher ratings of inattentive/attention problems.

**Table 8 Outcomes Controlling for Demographics by Hyperactive-Impulsive Trajectory Group Classification**

| | Very Low | | | Low | | | Moderate | | | High | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *n* | *M* | *SE* | *N* | *M* | *SE* | *n* | *M* | *SE* | *n* | *M* | *SE* | *F* | *p* |
| **HIA Behaviors** | | | | | | | | | | | | | | |
| DBD Hyperactive-Impulsive –T | 123 | 1.2[a] | 0.3 | 201 | 1.9[a] | 0.2 | 122 | 3.2[b] | 0.3 | 36 | 4.1[b] | 0.5 | 12.50 | .000 |
| DBD Inattentive – T | 123 | 2.1[a] | 0.4 | 201 | 3.3[a] | 0.3 | 122 | 4.7[b] | 0.4 | 36 | 4.0[a,b] | 0.7 | 7.37 | .000 |
| TRF Attention Problems – T | 123 | 52.0[a] | 0.4 | 201 | 53.2[a,b] | 0.3 | 122 | 54.6[b] | 0.4 | 36 | 54.1[a,b] | 0.8 | 6.27 | .000 |
| **Externalizing Symptoms** | | | | | | | | | | | | | | |
| DBD ODD – T | 122 | 0.8[a] | 0.3 | 201 | 1.7[b] | 0.2 | 122 | 1.9[b] | 0.3 | 36 | 3.4[c] | 0.5 | 7.93 | .000 |
| TRF Externalizing – T | 123 | 47.6[a] | 0.7 | 201 | 49.6[a,b] | 0.5 | 122 | 51.4[b] | 0.7 | 36 | 54.8[c] | 1.2 | 10.90 | .000 |
| **Internalizing Symptoms** | | | | | | | | | | | | | | |
| TRF Internalizing – T - NA | 123 | 49.6 | 0.7 | 201 | 50.8 | 0.5 | 122 | 50.0 | 0.7 | 36 | 49.7 | 1.2 | 0.92 | .431 |
| CDI Depression – C | 127 | 1.2[a] | 0.2 | 210 | 1.3[a] | 0.1 | 135 | 1.5[a] | 0.2 | 36 | 2.7[b] | 0.3 | 6.47 | .000 |
| LDSQ Loneliness – C | 125 | 24.1[a] | 0.8 | 203 | 24.4[a] | 0.6 | 132 | 25.7[a,b] | 0.8 | 35 | 29.5[b] | 1.5 | 3.85 | .010 |
| **Social Skills** | | | | | | | | | | | | | | |
| SSRS Total – T | 123 | 107.5[a] | 1.1 | 200 | 103.6[b] | 0.8 | 122 | 101.9[b,c] | 1.1 | 36 | 97.2[c] | 2.0 | 7.90 | .000 |
| **Peer Relationships** | | | | | | | | | | | | | | |
| CPR Prosocial – T | 123 | 1.7[a] | 0.03 | 201 | 1.6[b] | 0.02 | 120 | 1.5[a,b] | 0.03 | 36 | 1.4[c] | 0.06 | 6.47 | .000 |
| CPR Peer Victimization – T | 123 | 0.06[a] | 0.02 | 201 | 0.12[a,b] | 0.02 | 122 | 0.17[b] | 0.02 | 36 | 0.20[b] | 0.04 | 4.93 | .002 |
| CPR Relational Aggression – T | 123 | 0.2[a] | 0.03 | 201 | 0.4[b] | 0.03 | 120 | 0.4[b,c] | 0.03 | 36 | 0.5[c] | 0.06 | 7.59 | .000 |
| FQQ Friendship Quality – C | 126 | 4.4[a] | 0.04 | 209 | 4.3[a,b] | 0.03 | 134 | 4.4[a] | 0.04 | 36 | 4.1[b] | 0.07 | 4.96 | .002 |
| **Academic Achievement** | | | | | | | | | | | | | | |
| WJR Math | 120 | 114.8[a] | 1.3 | 194 | 110.9[a,b] | 1.0 | 132 | 107.9[b] | 1.3 | 35 | 113.5[a,b] | 2.5 | 4.93 | .002 |
| WJR Reading | 120 | 110.5 | 1.1 | 194 | 108.9 | 0.9 | 132 | 106.7 | 1.1 | 35 | 107.9 | 2.1 | 2.03 | .108 |

*Note.* The following measures provide a mean score of fifth and sixth grade functioning: Disruptive Behavior Disorders Questionnaire (DBD), Teacher Report Form (TRF),Child Depression Inventory (CDI), Social Skills Rating System (SSRS), Child Peer Relations (CPR), Friendship Quality Questionnaire (FQQ); the Loneliness and Dissatisfaction Questionnaire (LDSQ) and Woodcock-Johnson Psycho-Educational Battery – Revised (WJR) provide scores for fifth grade only;  M = maternal report, T = teacher report, C = child report; ODD = oppositional defiant disorder. Superscripts in each row differ significantly, as indicated by Bonferroni's post hoc comparisons.

### 6.3.3 Externalizing Symptoms

The MANCOVA conducted on the two measures of externalizing symptoms was significant, Pillai's Trace = 0.072, $F(6, 946) = 5.86$, $p = .000$. Follow-up univariate tests were also significant (see Table 8). A step-wise pattern emerged for these measures; post hoc comparisons revealed that girls in the 'very low' group scored lower on teacher ratings of ODD behavior in the classroom than girls in the 'low and 'moderate' trajectory groups, who scored lower than girls in the 'high' trajectory group. A similar pattern emerged for the ratings of overall externalizing problems, except that girls in the 'low group' did not differ from either the 'very low' or 'moderate' group, but all three groups did differ significantly from the 'high' group.

### 6.3.4 Internalizing Symptoms

The MANCOVA for this domain was significant, Pillai's Trace = 0.047, $F(9, 1374) = 2.42$, $p = .010$. Univariate $F$-tests indicated that teacher ratings of internalizing problems did not vary significantly as a function of trajectory group membership, whereas, child reports of depression and loneliness did. Girls in the 'high' group rated themselves as significantly more depressed than the girls in each of the other groups, who did not differ from one another. Girls in the 'high' group also reported that they were significantly more lonely than girls in the 'very low' and 'low' trajectory groups. Girls in the 'moderate' group did not differ from any of the other groups.

### 6.3.5  Social Skills

An ANCOVA revealed that there were significant group differences on teacher reports of social skills. Post hoc comparisons indicated that girls in the 'very low' trajectory group were rated as higher in social skills than girls in the 'low' and 'moderate' groups. The girls in the 'low' group were also seen as having more social skills than girls in the 'high' group.

### 6.3.6  Peer Relationships

The overall MANCOVA was significant, Pillai's Trace = 0.093, $F(12, 1389) = 3.71$, $p = .000$, as was each of the follow-up univariate tests. Several patterns emerged from the post hoc comparisons. First, girls in the 'very low' group differed significantly from the girls in the 'high' group in the expected direction across all four measures: prosocial skills, social aggression, peer victimization, and friendship quality. Differences failed to emerge between girls in the 'low' and 'moderate' groups on any of these measures. Girls in the 'very low' group were also rated as more prosocial and less socially aggressive than girls in the 'low' group. Girls in the 'moderate' group were rated by teachers as using more prosocial skills in peer interactions and they themselves reported higher friendship quality than did girls in the 'high' group.

### 6.3.7  Academic Achievement

The overall MANCOVA was significant, Pillai's Trace = 0.034, $F(6, 946) = 2.72$, $p = .013$. Follow-up univariate analyses indicated significant group differences on only the broad math

standard scores.  Post hoc comparisons indicated that girls in the 'very low' group obtained higher math scores than those in the 'moderate' trajectory group.

### 6.3.8   Effect Sizes

Effect sizes were examined for each domain by the values of partial eta squared.  The effect sizes were all small and ranged from .016 (internalizing symptoms) to .036 (externalizing symptoms).

## 6.4     HYPOTHESIS 2B: EXAMINING DEMOGRAPHIC AND OUTCOME MEASURES ON THE BASIS OF INATTENTIVE TRAJECTORY GROUP CLASSIFICATION

### 6.4.1   Demographics

Table 9 reveals the descriptive and inferential statistics associated with the demographic measures on the basis of trajectory group membership.  Significant group differences emerged on univariate $F$-tests performed on the income-to-needs and mother education variables.  Post hoc comparisons indicated that girls in the 'low stable' trajectory group had mothers with significantly fewer years of education than those in the 'very low' group.  Although girls in the 'moderate decreasing' group scored lower on this measure than those in the 'low stable' group, pairwise comparisons were not significant.  Post hoc tests performed on the income-to-needs ratio failed to produce significant differences between trajectory groups.  The Pearson chi-square tests indicated that race and household composition did not vary systematically by group.  As

such, only the income-to-needs ratio and mother education variables were utilized as covariates in the following analyses.

**Table 9 Demographics by Inattentive Trajectory Group Classification**

| | Very Low | | | Low Decreasing | | | Low Stable | | | Moderate Increasing | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *n* | *M* | *SD* | *N* | *M* | *SD* | *n* | *M* | *SD* | *n* | *M* | *SD* | *F/$\chi^2$* | *p* |
| Demographics | | | | | | | | | | | | | | |
| Income-to-Needs Ratio – M | 183 | 5.0 | 3.7 | 83 | 5.2 | 4.4 | 228 | 4.2 | 3.6 | 40 | 3.7 | 3.9 | 3.27 | .021 |
| Mother Education – M | 189 | 15.0[a] | 2.4 | 84 | 14.6[a,b] | 2.7 | 236 | 14.3[b] | 2.4 | 40 | 13.8[a,b] | 2.0 | 4.22 | .006 |
| Partner in Household (y/n) (%) –M | 181 | 79 | | 80 | 73.8 | | 224 | 72.8 | | 36 | 63.9 | | 4.44 | .218 |
| Child Race: Majority (%) – M | 189 | 83.6 | | 84 | 77.4 | | 236 | 82.2 | | 40 | 75.0 | | 2.68 | .443 |

*Note.* M = maternal report. Superscripts in each row differ significantly, as indicated by either Scheffé's post-hoc comparisons (continuous variables) or 2x2 chi-square tests (categorical variables).

### 6.4.2   HIA Behavior

The overall MANCOVA was significant for HIA behaviors, Pillai's Trace = 0.117, $F(9, 1467)$ = 6.63, $p$ = .000. Univariate *F*-tests were statistically significant for each of the measures in this domain (see Table 10). Post hoc comparisons revealed that girls in the 'very low' group were rated by teachers as less hyperactive-impulsive than girls in the 'low decreasing' and 'low stable' groups.

Girlsin the 'moderate increasing' group did not differ from either the 'very low' group or the 'low decreasing' and 'low stable' groups. Given that these girls achieved higher ratings than any other group ($M$=2.8) on this measure of hyperactivity-impulsivity, the small sample size most likely accounts for this phenomenon. In terms of inattention/attention problems, girls in the 'very low' group demonstrated fewer problems than girls in the 'low stable' group, who scored lower than those in the 'moderate increasing' group. Girls in the 'low decreasing' group differed significantly only from those in the 'moderate increasing' group.

**Table 10 Outcomes Controlling for Demographic Variables by Inattentive Trajectory Group Classification**

| | Very Low | | | Low Decreasing | | | Low Stable | | | Moderate Increasing | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *n* | *M* | *SE* | *N* | *M* | *SE* | *n* | *M* | *SE* | *n* | *M* | *SE* | *F* | *p* |
| **HIA Behaviors** | | | | | | | | | | | | | | |
| DBD Hyperactive-Impulsive –T | 174 | 1.5[a] | 0.3 | 79 | 2.8[b] | 0.4 | 206 | 2.5[b] | 0.2 | 36 | 3.0[a,b] | 0.5 | 5.33 | .001 |
| DBD Inattentive – T | 174 | 2.0[a] | 0.3 | 79 | 3.2[a,b] | 0.5 | 206 | 4.1[b] | 0.3 | 36 | 6.9[c] | 0.7 | 17.00 | .000 |
| TRF Attention Problems – T | 174 | 51.6[a] | 0.4 | 79 | 53.3[a,b] | 0.5 | 206 | 54.2[b] | 0.3 | 36 | 56.7[c] | 0.8 | 16.60 | .000 |
| **Externalizing Symptoms** | | | | | | | | | | | | | | |
| DBD ODD – T | 173 | 1.0[a] | 0.2 | 79 | 2.4[b] | 0.3 | 206 | 1.7[a,b] | 0.2 | 36 | 2.9[b] | 0.5 | 6.61 | .000 |
| TRF Externalizing – T | 174 | 48.1[a] | 0.6 | 79 | 51.1[b] | 0.8 | 206 | 50.6[b] | 0.5 | 36 | 53.4[b] | 1.2 | 7.25 | .000 |
| **Internalizing Symptoms** | | | | | | | | | | | | | | |
| TRF Internalizing – T | 174 | 49.0[a] | 0.6 | 79 | 50.1[a,b] | 0.8 | 206 | 50.8[a,b] | 0.5 | 36 | 53.0[b] | 1.2 | 3.72 | .011 |
| CDI Depression – C | 180 | 1.2[a] | 0.1 | 83 | 1.1[a] | 0.2 | 221 | 1.6[a,b] | 0.1 | 37 | 2.2[b] | 0.3 | 4.61 | .003 |
| LDSQ Loneliness – C | 175 | 23.6[a] | 0.7 | 81 | 24.0[a] | 1.0 | 215 | 25.6[a] | 0.6 | 37 | 31.5[b] | 1.4 | 9.02 | .000 |
| **Social Skills** | | | | | | | | | | | | | | |
| SSRS Total – T | 173 | 108.5[a] | 0.9 | 79 | 104.3[a,b] | 1.3 | 206 | 101.0[b] | 0.8 | 36 | 93.5[c] | 2.0 | 21.73 | .000 |
| **Peer Relationships** | | | | | | | | | | | | | | |
| CPR Prosocial – T | 174 | 1.6[a] | 0.03 | 79 | 1.5[a] | 0.04 | 205 | 1.5[a] | 0.02 | 35 | 1.4[b] | 0.06 | 6.88 | .000 |
| CPR Peer Victimization – T | 174 | 0.1[a] | 0.02 | 79 | 0.1[a,b] | 0.03 | 206 | 0.2[b] | 0.02 | 36 | 0.3[c] | 0.04 | 10.96 | .000 |
| CPR Relational Aggression – T | 174 | 0.3 | 0.03 | 79 | 0.4 | 0.04 | 205 | 0.4 | 0.03 | 35 | 0.5 | 0.06 | 3.51 | .015 |
| FQQ Friendship Quality – C | 178 | 4.4 | 0.03 | 83 | 4.3 | 0.05 | 218 | 4.3 | 0.03 | 37 | 4.3 | 0.07 | 1.12 | .341 |
| **Academic Achievement** | | | | | | | | | | | | | | |
| WJR Math | 165 | 113.8[a] | 1.2 | 81 | 110.9[a,b] | 1.6 | 210 | 109.9[a,b] | 1.0 | 36 | 105.4[b] | 2.4 | 4.14 | .007 |
| WJR Reading | 165 | 110.2 | 1.0 | 81 | 107.6 | 1.4 | 210 | 107.8 | 0.9 | 36 | 106.8 | 2.0 | 1.60 | .188 |

*Note.* The following measures provide a mean score of fifth and sixth grade functioning: Disruptive Behavior Disorders Questionnaire (DBD), Teacher Report Form (TRF), Child Depression Inventory (CDI), Social Skills Rating System (SSRS), Child Peer Relations (CPR), Friendship Quality Questionnaire (FQQ); the Loneliness and Dissatisfaction Questionnaire (LDSQ) and Woodcock-Johnson Psycho-Educational Battery – Revised (WJR) provide scores for fifth grade only; T = teacher report, C = child report; ODD = oppositional defiant disorder. Superscripts in each row differ significantly, as indicated by Bonferroni's post-hoc comparisons.

### 6.4.3 Externalizing Symptoms

The overall MANCOVA was highly significant, Pillai's Trace = 0.053, $F(6, 976)$ = 4.43, $p$ = .000. Univariate $F$-tests on teacher-rated ODD symptoms and overall externalizing problems revealed significant group differences. Girls in the 'very low' group were generally less externalizing on both measures than the girls in the 'low decreasing', 'low stable', and 'moderate increasing' trajectory groups, who did not differ from one another.

### 6.4.4 Internalizing Symptoms

The overall MANCOVA was significant, Pillai's Trace = 0.071, $F(9, 1419)$ = 3.81, $p$ = .000. Significant group differences emerged on the three measures comprising this domain; however, the pattern of differences was somewhat inconsistent across these measures. Generally, the girls in the 'very low' group consistently demonstrated better functioning than the girls in the 'moderate increasing' group, whereas girls in the 'low decreasing' and 'low stable' groups shared similar levels of functioning across all three measures. Girls in the 'very low' group scored lower than the girls in the 'moderate increasing' group on internalizing problems, but girls in the 'moderate increasing' group rated themselves as more lonely than the girls in each of the other three groups, and reported higher levels of depressive symptomatology than the girls in the 'very low' and 'low decreasing' groups.

### 6.4.5   Social Skills

An ANCOVA indicated there were significant group differences in social skills (see Table 10). Pairwise comparisons revealed a step-wise pattern of differences.  Girls in the 'very low' group were rated by teachers as more socially skilled than girls in the 'low stable' group, who were rated higher than girls in the 'moderate increasing' group.  Girls in the 'low decreasing' group did not differ in social skills from the 'very low' and 'low stable' group girls, but still differed significantly from girls in the 'moderate increasing' group.

### 6.4.6   Peer Relationships

The overall MANCOVA was significant for peer relationship measures, Pillai's Trace = 0.086, $F(12, 1428) = 3.50$, $p = .000$.  Follow-up univariate $F$-tests revealed significant group differences on teacher-rated measures of prosocial behaviors, peer victimization, and relational aggression, whereas child-reports of friendship quality did not vary significantly across trajectory groups. Post hoc comparisons on the relational aggression measure failed to reveal significant group differences, but measures of prosocial behavior and victimization did.  Overall, girls in the 'moderate increasing' group were significantly different from the other three trajectory groups in the context of peer interactions.  A step-wise pattern emerged on the victimization measure whereby scores in the 'very low' group differed from those in the 'low stable' group, which differed from those in the 'moderate increasing' group.  In terms of prosocial skills, girls in the three lowest groups were rated as significantly more skilled than the girls in the 'moderate increasing' group.

### 6.4.7 Academic Achievement

The overall MANCOVA was statistically significant, Pillai's Trace = 0.027, $F(6, 972) = 2.23$, $p = .038$. Univariate $F$-tests revealed significant group differences on only the broad math section of the WJ-R. Girls in the 'moderate increasing' group underperformed on the math measure in comparison to the girls in the 'very low' group.

### 6.4.8 Effect Sizes

The effect sizes for the inattentive behavior model were all small and ranged from .014 (academic achievement) to .039 (HIA behavior).

## 6.5 HYPOTHESIS 3B: EXAMINING DEMOGRAPHIC AND OUTCOME MEASURES ON THE BASIS OF JOINT TRAJECTORY GROUP CLASSIFICATION

The cross-classification process generates 16 different combinations of hyperactive-impulsive and inattentive behaviors (see Table 6). The number of girls in this study (n=549) is insufficient for examining outcomes on the basis of these 16 groups. However, because the pattern of co-occurrence of these two behaviors has both theoretical and clinical relevance, it was decided to combine several groups in order to investigate these outcomes. Girls cross-classified in the lowest hyperactive-impulsive and inattentive trajectory groups were combined into a category of 'low inattentive/low hyperactive-impulsive' behavior ('Low-Low'), which would be considered to represent normative levels of these behaviors (n=91). Girls in the two highest inattentive

groups and the 'very low' hyperactive-impulsive group were assigned to a 'high inattentive/low hyperactive-impulsive' group ('High IA') (n=25), which would be characterized as high on inattention. Girls cross-classified in the two highest hyperactive-impulsive trajectory groups and the 'moderate increasing' inattentive group were considered to be in the 'high inattentive/high hyperactive-impulsive' behavior group ('High IA+ HI') (n=36). Because the number of girls cross-classified in the lowest levels of inattentive behavior and two highest levels of hyperactive-impulsive behavior was extremely small (n=17), the 'low inattentive/high hyperactive-impulsive' ('High HI') was dropped from the following analyses.

### 6.5.1 Demographics

Table 11 presents the descriptive and inferential statistics associated with the demographic measures on the basis of the joint trajectory groups. ANOVAs and Pearson chi-square tests revealed that demographic variables varied significantly as a function of these four inattentive/hyperactive-impulsive categories of behavior. Post hoc comparisons of the income-to-needs ratio and the maternal education revealed that girls classified in the 'High IA + HI' group were significantly less wealthy and had mothers with fewer years of education than the girls in the other three groups. Inspection of the table also indicates that girls in the 'High IA+HI' subgroup are also more likely to be minority group members and to live in single mother households than girls in the other three groups. Thus, all the demographic variables were entered as covariates in the following analyses.

**Table 11 Demographics by Joint Trajectory Group Classification**

| | Low -Low | | | High IA | | | High IA + HI | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | *n* | *M* | *SD* | *n* | *M* | *SD* | *n* | *M* | *SD* | $F/\chi^2$ | *p* |
| Demographics | | | | | | | | | | | |
| Income-to-Needs Ratio – M | 88 | 5.6ª | 4.2 | 25 | 6.2ª | 4.4 | 41 | 2.9ᵇ | 2.6 | 8.40 | .000 |
| Mother Education – M | 91 | 15.1ª | 2.1 | 25 | 15.4ª | 2.1 | 42 | 13.6ᵇ | 1.9 | 9.93 | .000 |
| Partner in Household (y/n) (%) –M | 87 | 82.8 | | 24 | 79.2 | | 38 | 55.3 | | 10.96 | .004 |
| Child Race: Majority (%) – M | 91 | 86.8 | | 25 | 84.0 | | 42 | 61.9 | | 11.37 | .003 |

*Note.* M = maternal report. Superscripts in each row differ significantly, as indicated by either Scheffé's post-hoc comparisons (continuous variables) or 2x2 chi-square tests (categorical variables).

## 6.5.2 HIA Behaviors

The overall MANCOVA was significant, Pillai's Trace = 0.320, $F(6, 256) = 8.13$, $p = .000$, as were the follow-up univariate tests (see

Table 12). Post hoc comparisons on the DBD measure revealed that girls in the 'Low-Low' and 'High IA' groups shared similar

levels of hyperactive-impulsive behavior and inattention that were significantly lower than those of girls in the 'High IA+HI' group.  On the other hand, post hoc comparisons of the TRF measure indicated a step-wise pattern of group differences: girls in the 'Low-Low' group were rated lower than the girls in the 'High IA' group, who were rated lower than the 'High IA + HI' girls.

**Table 12 Outcomes Controlling for Demographic Variables by Joint Trajectory Group Classification**

| | Low-Low | | | High IA | | | High IA + High HI | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | $n$ | $M$ | $SE$ | $n$ | $M$ | $SE$ | $n$ | $M$ | $SE$ | $F$ | $p$ |
| **HIA Behaviors** | | | | | | | | | | | |
| DBD Hyperactive-Impulsive $-T$ | 84 | 0.8[a] | 0.2 | 22 | 1.1[a] | 0.5 | 30 | 3.2[b] | 0.4 | 12.44 | .000 |
| DBD Inattentive $- T$ | 84 | 1.4[a] | 0.4 | 22 | 2.8[a] | 0.7 | 30 | 6.6[b] | 0.7 | 21.89 | .000 |
| TRF Attention Problems $- T$ | 84 | 51.0[a] | 0.4 | 22 | 53.1[b] | 0.8 | 30 | 56.3[c] | 0.7 | 21.69 | .000 |
| **Externalizing Symptoms** | | | | | | | | | | | |
| DBD ODD $- T$ | 83 | 0.5[a] | 0.2 | 22 | 0.9[a] | 0.4 | 30 | 3.0[b] | 0.4 | 15.11 | .000 |
| TRF Externalizing $- T$ | 84 | 46.4[a] | 0.6 | 22 | 47.8[a] | 1.2 | 30 | 53.4[b] | 1.1 | 13.77 | .000 |
| **Internalizing Symptoms** | | | | | | | | | | | |
| TRF Internalizing $- T$ | 84 | 48.2[a] | 0.7 | 22 | 52.9[b] | 1.4 | 30 | 51.0[a,b] | 1.3 | 5.03 | .008 |
| CDI Depression $- C$ | 85 | 1.3[a] | 0.2 | 24 | 1.4[a,b] | 0.5 | 33 | 2.6[b] | 0.4 | 3.59 | .030 |
| LDSQ Loneliness $- C$ | 83 | 24.1[a] | 1.1 | 24 | 24.6[a,b] | 2.1 | 33 | 31.3[b] | 1.9 | 5.29 | .006 |
| **Social Skills** | | | | | | | | | | | |
| SSRS Total $- T$ | 84 | 109.5[a] | 1.2 | 22 | 103.7[a] | 2.3 | 30 | 92.9[b] | 2.1 | 22.25 | .000 |
| **Peer Relationships** | | | | | | | | | | | |
| CPR Prosocial $- T$ | 84 | 1.7[a] | 0.03 | 22 | 1.6[a] | 0.07 | 29 | 1.3[b] | 0.06 | 10.36 | .000 |
| CPR Peer Victimization $- T$ | 84 | 0.04[a] | 0.02 | 22 | 0.14[a] | 0.04 | 30 | 0.31[b] | 0.04 | 16.02 | .000 |
| CPR Relational Aggression $- T$ | 84 | 0.21[a] | 0.04 | 22 | 0.23[a,b] | 0.07 | 29 | 0.44[b] | 0.06 | 5.10 | .007 |
| FQQ Friendship Quality $- C$ | 85 | 4.4 | 0.05 | 23 | 4.4 | 0.09 | 33 | 4.3 | 0.08 | 0.55 | .579 |
| **Academic Achievement** | | | | | | | | | | | |
| WJR Math | 81 | 113.7 | 1.7 | 22 | 116.4 | 3.2 | 32 | 108.7 | 2.7 | 1.71 | .186 |
| WJR Reading | 81 | 109.9 | 1.3 | 22 | 114.0 | 2.5 | 32 | 107.7 | 2.2 | 1.82 | .166 |

*Note.* The following measures provide a mean score of fifth and sixth grade functioning: Disruptive Behavior Disorders Questionnaire (DBD), Teacher Report Form (TRF),Child Depression Inventory (CDI), Social Skills Rating System (SSRS), Child Peer Relations (CPR), Friendship Quality Questionnaire (FQQ); the Loneliness and Dissatisfaction Questionnaire (LDSQ) and Woodcock-Johnson Psycho-Educational Battery – Revised (WJR) provide scores for fifth grade only;  T = teacher report, C = child report; ODD = oppositional defiant disorder. Superscripts in each row differ significantly, as indicated by Bonferroni's post-hoc comparisons.

### 6.5.3 Externalizing Symptoms

The overall MANCOVA was significant, Pillai's Trace = 0.212, $F(4, 256) = 7.57$, $p = .000$. The univariate $F$-tests indicated that ODD symptoms and overall externalizing problems varied between the three groups of girls. Post hoc comparisons showed that girls in the 'High IA+ HI' group demonstrated more ODD symptoms and externalizing problems than girls in the 'Low-Low' and 'High IA' trajectory groups who did not differ from each other.

### 6.5.4 Internalizing Symptoms

The overall MANCOVA was significant, Pillai's Trace = 0.148, $F(6, 246) = 3.28$, $p = .004$. Follow-up univariate tests were significant on all three measures of internalizing problems. Regarding overall internalizing problems, girls in the 'High IA' group were rated by teachers as having more problems than girls in the 'Low-Low' group. A different pattern was found in the post hoc comparisons of child-rated depression and loneliness. Girls in the 'High IA + HI' group rated themselves as more lonely and depressed than girls in the 'Low-Low' group.

### 6.5.5 Social Skills

An ANCOVA on the SSRS was significant. Post hoc comparisons indicated that girls in the 'High IA + HI' group had significantly lower levels of social skills than girls in the other two groups.

### 6.5.6   Peer Relationships

The overall MANCOVA for peer relationship was significant, Pillai's Trace = 0.245, $F(8, 244) =$ 4.26, $p = .000$.   Follow-up univariate $F$-tests demonstrated significant group differences on measures of prosocial behavior, peer victimization, and relational aggression, but not on child-rated measures of friendship quality.   The post hoc comparisons reveal different patterns of differences across the teacher measures.   On the measure of prosocial skills in peer interactions, girls in the 'High IA + HI' group achieved significantly lower scores than girls in the other two groups.   Regarding peer victimization, girls in the 'High IA + HI' group were rated higher than girls in the 'Low-Low' and 'High IA' groups. These 'High IA + HI' girls also showed higher rates of relational aggression than girls in the 'Low-Low' group.

### 6.5.7   Academic Achievement

The overall MANCOVA was not statistically significant, Pillai's Trace = 0.039, $F(4, 256) =$ 1.28, $p = .278$.  For descriptive purposes, Table 12 presents the mean scores for these four groups on the math and reading sections of the WJ-R.

### 6.5.8   Effect Sizes

The effect sizes for the cross-classified groups were medium to large.   They ranged from .07 (internalizing symptoms) to .16 (HIA behavior).

# 7.0    DISCUSSION

The goals of the present study were to elucidate the manifestations and development of HIA behavior in a community sample of girls followed from kindergarten to fifth grade with the following objectives: 1) to model the developmental trajectories of hyperactive-impulsive and inattentive behavior, 2) to examine the degree of association between the models of hyperactive-impulsive and inattentive behavior, and 3) to determine whether child functioning in fifth and sixth grade varies as a function of trajectory group membership within each of these sets of trajectories. Consistent with previous studies of HIA behavior in boys, four trajectories were identified in both the hyperactive-impulsive and inattentive models. Contrary to extant literature and this study's hypotheses, all four of the hyperactive-impulsive trajectories demonstrated remarkably stable levels of behavior from kindergarten to fifth grade. Although girls in two of the inattentive trajectory groups ('low decreasing' and 'moderate increasing') showed a slight shift in their behavioral level across this same time period, the inattentive trajectories were also characterized by a high degree of stability between kindergarten and fifth grade. In line with hypotheses, teacher- and self-reported measures of behavioral, emotional, social, and academic functioning assessed in fifth and sixth grade varied by trajectory group membership in both the hyperactive-impulsive and inattentive models above and beyond differences in demographic indicators. Joint trajectory analyses revealed a step-wise pattern of conditional association between the two dimensions of behavior. The lowest levels of hyperactive-impulsive behavior

predicted low rates of inattentive behavior, whereas moderate and high levels of hyperactive-impulsive behavior predicted both low stable and moderate increasing levels of inattentive behavior. Likewise, low levels of inattentive behavior predicted low levels of hyperactive-impulsive behavior and moderate levels of inattentive behavior predicted moderate to high levels of hyperactive-impulsive behavior. Contrary to expectations and descriptions of ADHD in girls, which led to the hypothesis that girls are likely to manifest problems with inattention without co-occurring hyperactive-impulsive behavior problems, the likelihood of being assigned to both the highest trajectories of inattentive behavior and the lowest trajectories of hyperactive-impulsive behavior was extremely low. Finally, girls classified as 'High IA + HI' consistently underperformed on measures of behavioral, emotional, and social functioning in comparison to those classified as 'Low-Low' and 'High IA', above and beyond differences in demographic indicators.

The trajectories identified by the hyperactive-impulsive model suggest that girls in the general population demonstrate stable levels of hyperactive-impulsive behavior from kindergarten to fifth grade. This indicates that 1) the onset of high rates of hyperactive-impulsive behavior in girls occurs during or before kindergarten, 2) high rates of hyperactive-impulsive behavior in girls do not decrease during the elementary school years, and 3) girls exhibiting high rates of hyperactive-impulsive behavior in fifth grade were manifesting similar levels in kindergarten as well. These data suggest that high levels of hyperactive-impulsive behavior are not internalized as girls progress from kindergarten to fifth grade, but, rather, show a marked degree of continuity and stability. This is not entirely inconsistent with the literature on gender differences in the development of psychopathology, in which shifts in behavior occur either in early childhood (Keenan & Shaw, 1997) or during the transition to adolescence (Crick

& Zahn-Waxler, 2003). Nonetheless, given reports of decreasing rates of hyperactive-impulsive behavior in both clinical (Hart et al., 1995) and high-risk (Shaw et al., 2005) samples of boys, one would expect some change in girls' rates of hyperactive-impulsive behavior, as well. Shaw and colleagues (2005) used the same method of analysis (TRAJ) on their sample of high-risk males and identified at least one group of children demonstrating decreasing levels of HIA behavior from age two to 10. Although these differences may be due to differences in recruitment-settings, they corroborate the need to study the manifestations and development of HIA behavior in females.

The trajectories identified by the inattentive model indicate that the majority of girls in the general population demonstrate exceptionally low levels of inattention from kindergarten to fifth grade. Three of the four trajectories are defined by inattentive scores of one or less and the average score of the 'moderate increasing' group never surpasses four (out of eight). Thus, on average, girls are presenting with lower rates of inattention than hyperactivity from kindergarten to fifth grade. This is inconsistent with theories regarding the manifestation of HIA behaviors in girls, in which it is posited that girls are more likely to exhibit high levels of inattention than hyperactivity (Arnold, 1996). In terms of the shape of the trajectories, overall rates of inattentive behavior were characterized by less stability and more change than rates of hyperactive-impulsive behavior across the elementary school years. It appears that rates of inattentive behavior increase from kindergarten to fifth grade for a subgroup of girls who initially demonstrated moderate levels of inattentive behavior in kindergarten. Thus, it can be posited that high rates of inattentive behavior emerge in girls as they progress from kindergarten to fifth grade. Approximately 60% of the sample evidenced low levels of inattentive behavior in kindergarten; however, 18.6% decreased in their rates of inattentive behavior as they approached

fifth grade, whereas the remainder demonstrated stable levels across this time period. These trajectory patterns are inconsistent with studies of the developmental course of inattentive behavior in boys with ADHD, in which levels of inattention were found to be relatively stable between age eight and 15 (Hart et al., 1995).

Although the levels of hyperactive-impulsive behavior characterizing the 'moderate' and 'high' trajectory groups are relatively, rather than absolutely, high in terms of total scores, girls in these two trajectories consistently differed from the two lowest trajectories on both background characteristics and behavioral, emotional, social, and academic outcomes measured in fifth and sixth grade. A similar pattern is observed with the inattentive trajectories: girls in trajectories defined by patterns of 'low stable' and 'moderate increasing' levels of inattentive behavior differed from girls in trajectories characterized by 'low decreasing' and 'very low' patterns of behavior on both background characteristics and fifth and sixth grade outcome measures, even though the overall rates were exceptionally low. This is a key finding because it extends our understanding of the degree and extent to which deviations from gender-specific, in addition to age-specific, thresholds of normative behavior may be associated with adjustment difficulties (Arnold, 1996).

Given the degree of association between the hyperactive-impulsive trajectories and the inattentive trajectories ascertained by the joint trajectory model, such that patterns of group differences within each model of behavior are highly unlikely to be driven entirely by that behavior alone, it would be best to discuss differences in background characteristics and on outcome measures as a function of joint trajectory group membership. Moreover, the effect sizes for the joint trajectory model ranged from medium to large, whereas those for the hyperactive-impulsive and inattentive trajectory models were consistently small. These effect size

differences further suggest that examining the joint development of hyperactive-impulsive and inattentive behavior may be more meaningful than examining the development of either behavior alone.

The joint trajectory analyses conducted on these data provide fundamental information on the development of HIA behavior in girls. First, they advance current knowledge of how hyperactive-impulsive behavior and inattentive behaviors are related to each other across development in girls. Although they have been established as separate, though closely related, dimensions of behavior (Lahey et al., 1994 ), these data corroborate this phenomenon in girls. The present findings reveal that girls who demonstrate moderate to high levels of hyperactive-impulsive behavior are also inclined to exhibit low stable to moderate increasing rates of inattentive behavior, and girls exhibiting low stable to moderate increasing rates of inattentive behavior are also most likely to demonstrate moderate to high levels of hyperactivity. On a similar note, girls with low levels of hyperactive-impulsive behavior are most likely to also exhibit low levels inattentive behavior and vice versa. Together, these patterns suggest that the manifestations and development of both dimensions of hyperactive-impulsive and inattentive behavior are strongly associated in girls.

A crucial result from the joint trajectory analyses pertains to the probabilities related to the assignment of girls to both the 'moderate increasing' inattentive and 'very low' hyperactive-impulsive trajectory groups. The conditional and joint probabilities of such an occurrence are extremely low, with only one girl actually cross-classified to such a category. Indeed, the majority of girls in the 'moderate increasing' inattentive group were most likely to be cross-classified to the 'moderate' and 'high' hyperactivity groups. As such, the 'High IA' group is comprised almost entirely of girls who were assigned to both the 'low stable' and 'very low'

hyperactive-impulsive trajectory groups. Furthermore, girls in the 'low stable' group were more likely to be assigned to the 'low' and 'moderate' than to the 'very low' hyperactive-impulsive trajectory groups. The finding that moderate to high rates of inattention rarely manifest in the absence of co-occurring moderate to high rates of hyperactivity contradicts extant theories on the manifestation of HIA behavior in girls (Arnold, 1996). Most researchers would expect a substantial proportion of girls in community settings to exhibit high levels of inattention only (Arnold, 1996). However, these findings do converge with those of Hinshaw (2002) and Biederman and colleagues (1999), in which girls were more likely to be diagnosed with the combined subtype than the inattentive subtype of ADHD. Thus, the rates reported in these two referred samples may accurately reflect the patterns of manifestation of these behaviors in the general population.

In terms of findings related to background characteristics, girls classified as 'High IA + HI' were more likely to come from backgrounds distinguished by more poverty, single parent households, low maternal education, and racial diversity than girls in the 'Low-Low' and 'High IA' groups. Given that most of these indicators are environmental features that have been implicated in the etiology of ADHD, these findings are not surprising (Barkley, 1998). Hinshaw's (2002) sample of girls did not vary on similar demographic variables as a function of diagnostic status. This inconsistency is likely grounded in the differences in sample recruitment and highlights the need to study population-based, as well as referred, samples of girls.

In line with hypotheses, girls in the 'High IA + HI' group uniformly looked worse on measures of behavioral, emotional, and social competence in comparison to girls in the 'Low-Low' group. These findings converge with those of Hinshaw (2002) and Biederman and colleagues (1999), in which girls with the combined subtype ADHD showed more impairment

on measures within these domains of functioning than did the comparison girls.  The findings of the current study extend those of previous research because they indicate that girls in community settings who demonstrate elevated levels of hyperactive-impulsive and inattentive behavior in comparison to their same-age and same-sex peers are perceived by their teachers as demonstrating difficulties in important domains of functioning.  For example, they view the 'High IA + HI' girls as more oppositional, disruptive, and aggressive with peers than girls in the 'Low-Low' group, as well as less socially competent.  If these relatively subtle increases in the rates of hyperactive-impulsive and inattentive behaviors in comparison to peers affect teacher-ratings of functioning in this sample, it is highly unlikely that girls demonstrating extremely high levels of these behaviors would be under-recognized or tolerated by teachers in the general population.  Thus, the under-representation of girls with ADHD in clinic settings in comparison to community settings does not appear to be explained by less noxious behavior in the classroom.  Moreover, although the 'High IA + HI' girls rated themselves as more lonely and depressed than the 'Low-Low' girls, teachers did not rate them higher on internalizing problems.  Rates of co-occurring internalizing problems, therefore, do not counteract the effects of externalizing problems in the classroom context, another reason postulated for the under-referral of girls for treatment (Arnold, 1996; Biederman, 1999),.

Girls in the 'High IA + HI' and 'High IA' groups differed on all measures of behavioral competence and most measures of social competence, but did not differ in terms of teacher-reports of internalizing problems and self-reports of loneliness and depression.  A similar finding was reported by Hinshaw (2002), in which the girls with the combined and inattentive subtype differed significantly on mother-, teacher-, and camp counselor-ratings of externalizing behavior and peer interactions, but did not differ from each other on maternal-ratings of internalizing

problems and self-reports of depression. These patterns bolster Hinshaw's (2002) findings because they suggest that even non-clinical levels of hyperactive-impulsive behavior are associated with problems with aggression and acting out, and non-clinical levels of inattentive behavior are linked to emotional problems in girls. However, it must be noted that 'High IA' girls differ from the 'Low-Low' girls only in terms of teacher-ratings of overall internalizing problems. Thus, although they do not differ from the 'High IA + HI' girls on measures of emotional competence, they do not differ from the 'Low-Low' girls either. They fall on the continuum between the 'Low-Low' and 'High IA + HI' girls.

Significant differences failed to emerge between the girls in the 'High IA' and 'Low-Low' group, except in the case of teacher ratings of internalizing problems. This result was unexpected, yet not entirely surprising. The girls in the 'High IA' group are predominantly those who were assigned to the 'low stable' trajectory, which denotes a minimal rate of inattention. Inattentive behavior expressed at such low levels may not interfere with functioning at the level of classroom behavior, peer interaction, and academic performance. Thus, it would be inadvisable to compare these girls to girls diagnosed with the inattentive subtype in these domains of functioning. Interestingly, however, teachers do perceive these girls as somewhat more internalizing than the girls in the 'Low-Low' group. This suggests that subtle elevations of inattentive behavior are associated with a substantive rise in internalizing behaviors, as well. Moreover, these girls do not differ significantly from the 'High IA + HI' girls in terms of self-reported depression and loneliness, as stated above, indicating that they are aware of the peer and internal difficulties that they are experiencing as a function of their slight shifts in inattentive behavior.

### 7.1.1 Limitations and Future Directions

There are several limitations to this study that deserve further discussion. First and foremost, these trajectories are not commensurate with clinical diagnoses of ADHD. Although the person-centered orientation of trajectory analysis identifies subgroups of girls within the sample demonstrating similar behavioral and developmental patterns of HIA behavior, these trajectory groups are based upon symptom levels and not diagnostic criteria. As such, the trajectory groups characterized by the highest and most persistent levels of either inattentive or hyperactive-impulsive behavior or both should not be considered clinically diagnostic. Some girls within the group might meet diagnostic thresholds for ADHD, whereas others might not. Thus, comparing outcomes of girls cross-classified as 'High IA', 'High IA + HI', and 'Low-Low', is not analogous to studies comparing outcomes of girls with and without ADHD. However, the differences reported herein were robust across both domains and reporters. Moreover, because the use of dimensional measures of symptoms is a necessary component to understanding the manifestations and developmental course of HIA behaviors, these comparisons were a valuable contribution to the field. The finding that sub-clinical levels of HIA behaviors predict poorer child behavioral, emotional, and social functioning is critical for understanding female-specific manifestations of ADHD. As such, future examinations of the risk factors, antecedents, and outcomes of girls with and without ADHD should include dimensional measures of symptoms. This is essential for determining whether the current diagnostic thresholds should be modified to include gender-specific thresholds of behavior.

The composite data used in the analyses were based entirely on maternal-reports of hyperactive-impulsive and inattentive behavior, rather than the combination of maternal- and teacher-reported data often used in research studies. The cross-informant method of data

collection is particularly important in the context of ADHD research because children must demonstrate difficulties with these behaviors across multiple situations, especially home and school, to meet diagnostic criteria (Barkley, 1998). Therefore, the levels of behavior in the various trajectories may underestimate 'true' levels of behavior demonstrated across different contexts. However, one of the strengths of this study is its use of separate informants for HIA behaviors (mother) and measures of child functioning (teacher and child), which eliminates the problems of shared reporter variance common to most population-based studies. Moreover, given that the current analyses were based upon the mean of fifth and sixth grade measures, these findings should be considered highly reliable. Consequently, the differences in child adjustment according to trajectory group membership are a valid estimation of differences in the population, regardless of actual behavioral level of the trajectory groups.

The CBCL assesses child functioning in various domains and is used to ascertain whether a child is performing at a level comparable to other children of the same sex and age group. This measure can be used to determine whether a child is at risk for clinical impairment, but it is not a diagnostic tool. This is particularly relevant for ADHD symptoms in which the items pertaining to these symptoms comprise the factor 'Attention Problems', rather than ADHD. The items used to assess inattentive and hyperactive-impulsive behavior, therefore, were chosen as reflecting either the hyperactive-impulsive or inattentive subtype, but the items do not map onto the symptoms reflected in the *DSM-IV*. Future studies should, thus, utilize more complete symptom lists or diagnostic measures in examining trajectories of ADHD.

Attrition analyses revealed that the girls with enough data to participate in this study came from more educated and affluent backgrounds than those who did not provide sufficient data. Therefore, the data used in the current study are not representative of the entire population

of girls in this age range. However, this is the first effort to examine the manifestations, developmental course, and associated outcomes of HIA behavior in a large, population-based sample of girls. As such, the information contained herein provides a framework for better conceptualizing the female-specific manifestations, developmental course, and associated outcomes of HIA behavior and, more specifically, ADHD.

### 7.1.2 Summary and Implications

The findings from this study indicate that girls in the general population follow distinct trajectories of hyperactive-impulsive and inattentive behavior between kindergarten and fifth grade. The hyperactive-impulsive trajectories were all characterized by stable levels of behavior across this time-period, whereas the inattentive trajectories demonstrated some change. Although the trajectories derived from both models were never extremely elevated, there were still differences in outcomes across various domains of functioning on the basis of group membership. Girls in the highest trajectories appear to have more difficulties with behavioral, emotional, social, and academic performance than girls in the lower trajectory groups. Joint trajectory analyses revealed that, contrary to expectation, girls are more likely to have high levels of both inattentive and hyperactive-impulsive behavior than high levels of inattention alone. Moreover, girls in the 'High IA + HI' group were perceived by teachers as more oppositional, less socially skilled, and more aggressive with peers than girls in the other groups. This suggests that hyperactive-impulsive girls are easily distinguished in the classroom and, thus, do not appear to be under-recognized as such by their teachers. Thus, researchers must determine another reason for the under-representation of girls in the clinic settings.

**REFERENCES**

Abikoff, H., Jensen, P.S., Arnold, L. L. et al. (2002). Observed classroom behavior of children with ADHD: Relationship to gender and comorbidity. *Journal of Abnormal Child Psychology, 4,* 349-359.

Achenbach, T. M. (1991). *Manual for the Teacher Report Form and Profile*. Burlington, VT: University of Vermont, Department of Psychiatry.

American Psychiatric Association. (1980). *Diagnostic and statistical manual of mental disorders third edition (DSM III)*. Washington, DC: American Psychiatric Association

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders fourth edition (DSM IV)*. Washington, DC: American Psychiatric Association.

Arnold, L.E. (1996). Sex differences in ADHD: Conference summary. *Journal of Abnormal Child Psychology*, *24,* 555–569.

Asher, S.R., Hymel, S., & Renshaw, P.D. (1984). Loneliness in children. *Child Development, 55,* 1456-1464.

Barkley**,** R. A. (1998) Attention-deficit/hyperactivity disorder. In E.J. Mash and R.A. Barkley (Eds.) *Treatment of childhood disorders (2nd ed.)* (pp. 55-110).  New York, NY, US: Guilford Press.

Barkley, R.A. (2002). Attention-deficit hyperactivity disorder. In E.J. Mash & R.A. Barkley (Eds.), *Child psychopathology (2ⁿᵈ Ed)(*pp. 63–112). New York: Guilford Press.

Barkley, R.A, Fischer, M., Edelbrock, C., & Smallish, L. (1991). The adolescent outcome of

    hyperactive children diagnosed by research criteria: III. Mother-child interactions, family

    conflicts and maternal psychopathology. *Journal of Child Psychology and Psychiatry, 32,*

    233-255.

Barkley, R.A, Fischer, M., Smallish, L., & Fletcher, K. (2004) Young adult follow-up of

    hyperactive children: antisocial activities and drug use. *Journal of Child Psychology and*

    *Psychiatry, 45,* 195-211.

Biederman, J., Faraone, S.V., Spencer, T., Wilens, T., *et al.* (1993). Patterns of psychiatric

    comorbidity, cognition, and psychosocial functioning in adults with attention deficit

    hyperactivity disorder. *American Journal of Psychiatry, 150,* 1792-1798.

Biederman, J., Faraone, S.V., Mick, E., et al. (1999). Clinical correlates of ADHD in females:

    Findings from a large group of girls ascertained from pediatric and psychiatric referral

    sources. *Journal of the American Academy of Child and Adolescent Psychiatry, 38,* 1-9.

Biederman, J., Faraone, S.V., Taylor, A., Sienna, M., Williamson, S., & Fine, C. (1998).

    Diagnostic continuity between child and adolescent ADHD: Findings from a longitudinal

    clinical sample. *Journal of the American Academy of Child and Adolescent Psychiatry*,

    *37*, 305–313.

Blachman, D & Hinshaw, S. (2002). Patterns of friendship among girls with and without

    attention-deficit/hyperactivity disorder. *Journal of Abnormal Child Psychology, 30,* 625-

    640.

Clark**,** C., Prior, M., **&** Kinsella, G. (2002). The relationship between executive function

    abilities, adaptive behaviour, and academic achievement in children with externalizing

    behaviour problems. *Journal of Child Psychology and Psychiatry, 43,* 785-796.

Consensus Development Panel (2000). National Institutes of Health Consensus Development

      Conference Statement: Diagnosis and treatment of attention-deficit/hyperactivity disorder

      (ADHD). *Journal of the American Academy of Child and Adolescent Psychiatry, 39,* 182-

      193.

Costello, E.J. (1990). Child psychiatric epidemiology: Implications for clinical research and

      practice. In B.B Lahey, and A.E Kazdin, Alan (Eds). *Advances in clinical child*

      *psychology*, *Vol. 13* (pp. 53-90). New York, NY, US: Plenum Press.

Crick, N.R., Bigbee, M.A., & Howes, C. (1996). Gender differences in children's normative

      beliefs abot aggression: How do I hurt thee? Let me count the ways. *Child Development,*

      *67,* 1003-1014.

Crick, N.R., & Zahn-Waxler, C. (2003). The development of psychopathology in females and

      males: Current progress and future challenges. *Development and Psychopathology, 15,*

      719-742.

Cummings, E. M, Davies, P.T. & Campbell, S.B. (2000). Developmental psychopathology and

      family process: Theory, research, and clinical implications. (pp. xiv - 493)New York,

      NY, US: Guilford Press.

Greene, R.W., Biederman, K., Faraone, S.V., Monuteaux, M.C. et al. (2001). Social impairment

      in girls with ADHD: Patterns, gender comparisons, and correlates. *Journal of the*

      *American Academy of Child and Adolescent Psychiatry, 40,* 704-710.

Gresham, F.M., & Elliot, S.N. (1991). *Social skills rating system.* Circle Pines, MN: American

      Guidance Service.

Hart, E.L., Lahey, B.B., Loeber, R., Applegate, B., Green, S.M., & Frick, P.J. (1995).
Developmental change in attention-deficit hyperactivity disorder in boys: A four-year
long longitudinal study. *Journal of Abnormal Child Psychology, 23,* 729-749.

Hinshaw, S.P. (1992). Externalizing behavior problems and academic underachievement in
childhood and adolescence: Causal relationships and underlying mechanisms.
*Psychological Bulletin*, *111,* 127–155.

Hinshaw, S.P. (2001). Preadolescent girls with attention-deficit/hyperactivity disorder: I.
Background characteristics, comorbidity, cognitive and social functioning, and parenting
practices. *Journal of Consulting and Clinical Psychology, 70,* 1086-1098.

Hinshaw, S.P., & Melnick, S.M. (1995). Peer relationships in boys with attention-
deficit/hyperactivity disorder with and without comorbid aggression. *Development and
Psychopathology, 7,* 627-647.

Hinshaw, S.P., Owens, E. B., Sami, N., & Fargeon, S. (2006). Prospective follow-up of girls
with attention-deficit/hyperactivity disorder into adolescence: Evidence for continuing
cross-domain impairment. *Journal of Consulting and Clinical Psychology, 74,* 489-499.

Jensen, P.S., Shervette, R.E., Xenakis, S.N., & Richters, J. (1993) Anxiety and depressive
disorders in attention deficit disorder with hyperactivity: New findings. *American
Journal of Psychiatry, 150,* 1203-1209.

Keenan, K., Loeber, R., & Green, S. (1999). Conduct disorder in girls: A review of the literature.

Klein, R.G., & Mannuzza, S. (1991). Long-term outcome of hyperactive children: A review.
*Journal of the American Academy of Child and Adolescent Psychiatry*, 30, 383–
387.*Clinical Child and Family Psychology Review, 2,* 3-19.

Kovacs, M. (1992). *The Children's Depression Inventory (CD) manual.* North Tonawanda, NY:

Multi-Health Systems.

Ladd, G.W., & Profilet, S.M. (1996). The child behavior scale: A teacher-report measure of young children's aggressive, withdrawn, and prosocial behaviors. *Developmental Psychology, 32,* 1008-1024.

Loeber, R., Green, S.M., Lahey, B.B., Christ, M.A., et al. (1992). Developmental sequences in the age of onset of disruptive child behaviors. *Journal of Child and Family Studies, 1,* 21–41.

Nagin, Daniel S**.** (1999). Analyzing developmental trajectories: A semiparametric, group-based approach. *Psychological Methods, 4,* 139-157.

Nagin, D. S. (2005). *Group-based Modeling of Development.* Cambridge, MA: Harvard University Press.

Newcorn, J.H., Halperin, J.M.,  Jensen, P.S. et al. (2001) Symptom profiles in children with *ADHD: Effects of comorbidity and gender. Journal of the American Academy of Child and Adolescent Psychiatry,40,* 137-146.

NICHD Early Child Care Research Network (1999). Child care and mother-child interaction in the first 3 years of life. *Developmental Psychology, 35,* 1399-1413.

Parker, J.G., & Asher, S.R. (1993). Friendship and friendship quality in middle childhood: Links with peer group acceptance and feelings of loneliness and dissatisfaction. *Developmental Psychology, 29,* 611-621.

Pelham, W.E. Jr., Gnagy, E.M., Greenslade, K.E., & Milich, R. (1992). Teacher ratings of DSM-III-R symptoms for the disruptive behavior disorders. *Journal of the American Academy of Child and Adolescent Psychiatry, 32,* 210-219.

Peris, T.S., & Hinshaw, S.P. (2003). Family dynamics and preadolescent girls with ADHD: the relationship between expressed emotion, ADHD symptomatology, and comorbid disruptive behavior. *Journal of Child Psychology and Psychiatry, 44,* 1177-1190.

Scahill, L., & Schwab-Stone, M. (2000). Epidemiology of ADHD in school-age children. *Child and Adolescent Psychiatric Clinics of North America, 9,* 541-555.

Shaw, D.S., Lacourse, E., & Nagin, D.S. (2005). Developmental trajectories of conduct problems and hyperactivity from ages 2 to 10. *Journal of Child Psychology and Psychiatry, 46,* 931-942.

Treuting, J., & Hinshaw, S.P. (2001) Depression and self-esteem in boys with attention-deficit/hyperactivity disorder: Associations with comorbid aggression and explanatory attributional mechanisms. *Journal of Abnormal Child Psychology, 29,* 23-39.

Willoughby, M.T. (2003) Developmental course of ADHD symptomatology during the transition from childhood to adolescence: A review with recommendations. *Journal of Child Psychology and Psychiatry, 44,* 88-106.

Woodcock, R.W., & Johnson, M.B. (1989). *Woodcock-Johnson Psycho-Educational Battery-Revised.* Allen, TX: DLM Teaching Resources.

Woodcock, R.W., & Johnson, M.B. (1990). *Woodcock-Johnson Psycho-Educational Battery-Revised.* Allen, TX: DLM Teaching Resources.