

Social Functioning in DSM-IV Attention-Deficit/Hyperactivity Disorder:
A Multi-dimensional Examination of Children and Adolescents

by

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Social Functioning in DSM-IV Attention-Deficit/Hyperactivity Disorder:

A Multi-dimensional Examination of Children and Adolescents

Thesis directed by Professor Erik G. Willcutt

Objective: This study was designed to provide a comprehensive evaluation of social functioning in individuals with Attention-Deficit/Hyperactivity Disorder (ADHD). Marked impairment in social functioning is well established for children with ADHD. Yet, the social impairment often associated with the presence of ADHD symptoms is not fully characterized in the research literature. *Methods:* An unselected sample of children and adolescents and their parents and teachers completed a battery of measures to assess ADHD symptoms and specific aspects of social functioning, including social skills, empathy, friendship, and aggression at three different time points. *Results:* ADHD symptoms in children are associated with significant impairment in social functioning. The strongest associations were found for prosocial behavior and social skills, impairment with peers and adults, social cognition, and aggression, and significant but weaker associations for social acceptance and rejection, social isolation and withdrawal, affective empathy, and family relationships. Symptom dimensions and subtypes differentially predicted impairment such that inattentive symptoms were more strongly associated with shy, withdrawn, and isolating behavior whereas hyperactive/impulsive symptoms were more strongly associated with aggression. Additionally, ADHD symptoms independently predicted social impairment after controlling for comorbid psychopathology. *Conclusions:* Overall, the results suggest that social functioning in ADHD is impaired across a variety of domains and further study is warranted to guide future development of assessments and treatment. Results also support the concurrent and discriminant validity of the DSM-IV inattention and hyperactivity-impulsivity symptoms and nominal subtypes.

Keywords: ADHD, child psychopathology, social functioning

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CHAPTER I

Introduction

ADHD: Definition and Diagnostic Validity

Attention-Deficit/Hyperactivity Disorder (ADHD) is characterized behaviorally by developmentally inappropriate symptoms of inattention and/or hyperactivity that cause clinically significant impairment in two or more areas of the individual's life (American Psychiatric Association, 2000). The DSM-IV ADHD diagnosis is conceptualized as consisting of symptoms falling on two dimensions, inattentive and hyperactive/impulsive, which have been used to differentiate three subtypes of the disorder: predominantly inattentive (ADHD-I), predominantly hyperactive/impulsive (ADHD-H), and combined (ADHD-C) types (APA, 2000). While the validity of the overall DSM-IV ADHD diagnosis is consistently supported by strong associations with functional impairment, the validity of the DSM-IV subtype model remains controversial, though the general symptom dimensions have remained in the DSM-5, the most recent revision of ADHD diagnostic criteria, as presentation specifiers (e.g., American Psychiatric Association, 2013; Willcutt et al., 2012; Lahey & Willcutt, 2010; Lee et al., 2008; Carlson, Shin, & Booth, 1999). Specifically, initial studies of etiology, treatment response, and academic and neuropsychological functioning have provided weak evidence for the discriminant validity of ADHD-I and ADHD-C, suggesting that additional research is needed to test whether the DSM-IV subtypes, or DSM-5 presentation specifiers, are consistently differentiated by distinct profiles on measures of important external correlates (e.g., Willcutt et al., 2012).

Extensive research has demonstrated that symptoms of ADHD lead to significant concurrent and future impairment in a variety of social domains (see Willcutt, et al., 2012; McQuade & Hoza, 2008; Hoza, 2007 for reviews), and the most promising initial evidence for differential impairment by subtype has been reported in studies of social functioning (e.g., A. Y. Mikami, Huang-Pollock, Pfiffner, McBurnett, & Hangai, 2007; Hinshaw, 2002; Maedgen &

Carlson, 2000; Lahey et al., 1998). However, results are often mixed and data that directly compare the subtypes remain sparse, particularly for measures of social functioning that go beyond global measures of social dysfunction (Willcutt et al., 2012). Taken together, these results underscore the potential importance of social impairments among individuals with ADHD, but suggest that additional research is needed to fully characterize these difficulties.

The current study. The current study was designed to capture a comprehensive picture of the interplay among symptoms and subtypes of ADHD and the multiple component skills and characteristics required to successfully navigate the social world. Additionally, the study was designed to allow an initial longitudinal examination of social functioning with three cross-sectional snapshots of social functioning. Individuals who had previously participated in two prior waves of two longitudinal studies participated in a third wave of data collection of those studies by completing an extensive battery of measures of social functioning and other key variables that may mediate or moderate social impairment. The goal of this study is to facilitate refinement of models of social functioning in all individuals with ADHD, and to provide important new information regarding the discriminant validity of the DSM-IV ADHD symptom dimensions and subtypes based on impairment in social functioning.

Overall Social Impairment in ADHD

Extensive research has been conducted demonstrating that symptoms of ADHD negatively impact current social functioning (see Willcutt, et al., 2012; McQuade & Hoza, 2008; Hoza, 2007 for reviews). Further, it has been shown that children with ADHD plus social deficits are at risk for increased adverse outcomes (e.g., Bagwell, Molina, Pelham, & Hoza, 2001; Wahlstedt, Thorell, & Bohlin, 2008). Additionally, while some treatments have been shown to be somewhat efficacious in improving social function (Antshel & Remer, 2003), to date no interventions are “well established” (de Boo & Prins, 2007), and little change is seen in social

status for these children, especially as measured by peer sociometric ratings (Hoza, Mrug, et al., 2005; Storebo, Gluud, Winkel, & Simonsen, 2012).

As many as fifty percent of children with ADHD are rejected by their peers (Hoza, Mrug, et al., 2005). Many children with ADHD have a greater social impact, meaning their social behaviors are noticed more than their peers', they are less socially preferred, they are less likely to have close friendships, and they have greater conflict with peers and adults than comparison children (e.g., Hoza, Gerdes, et al., 2005; Nijmeijer et al., 2008; Greene et al., 2001). The literature suggests rejection occurs in part because children with ADHD are found to be intrusive, argumentative, and inappropriate in social interactions as rated by adults and peers in their lives (e.g., Landau, Milich, & Diener, 1998; McQuade & Hoza, 2008). In social interaction tasks, Normand et al. (2011) observed that children with ADHD were more insensitive and self-centered when negotiating with friends, and were often more dominant than their typical friends.

Studies have shown that a child's negative reputation often persists and that it can be a barrier to changes in social status (e.g., Price & Dodge, 1989; Hoza, 2007). Further, this reputation is established quickly. In studies examining dyad or group interactions of newly acquainted children with ADHD and comparison children, children with ADHD had lower social preference scores than comparison children after one hour (Hodgens, Cole, & Boldizar, 2000). Evidence in the literature also shows that a child's low social status has been established by the age of 7 years old (Hoza, Mrug, et al., 2005). This is not only impairing to children with ADHD in the present because peer rejection is associated with negative long-term outcomes including increased rates of substance abuse, academic problems, and psychopathology (e.g. Bagwell et al., 2001; Greene, Biederman, Faraone, Sienna, & Garcia-Jetton, 1997).

Some researchers have theorized that friendships might be a protective factor against peer rejection for children with ADHD (Cardoos & Hinshaw, 2011; Glass, Flory, & Hankin, 2012). There has been little research on friendships in ADHD though this has been identified as

a necessary direction for understanding social functioning in children with ADHD in reviews of the literature (Hoza, 2007; Mikami, 2010). While one study has shown that at least one good friendship is protective against peer victimization for all children, the findings did not support that this was moderated by ADHD status (Cardoos & Hinshaw, 2011). Generally, the research shows that children with ADHD have fewer mutual friendships, find their friendships to be less satisfying, and find more negative and less positive qualities in their friendships (e.g. Normand et al., 2011; Blachman & Hinshaw, 2002).

Social Impairment by Dimension

The DSM-IV model of two symptom dimensions, inattentive and hyperactive/impulsive, is valid across all measures of functional impairment (e.g. Willcutt et al., 2012; Lahey et al., 2008). Factor analyses indicate the two dimensions load on separate factors, and are separable from symptoms of common comorbid disorders (e.g. Lahey et al., 2008; Lahey & Willcutt, 2010; Gomez, Burns, Walsh, & Hafetz, 2005; DuPaul et al., 2001). One aspect of functional impairment often used to validate the symptom dimensions is social functioning. A recent meta-analysis demonstrated that there are no significant differences between the two symptom dimensions on overall social functioning (Willcutt et al., 2012). However, differences become apparent when examining individual characteristics and skills required for adequate social performance. The literature has demonstrated that inattentive symptoms have a significantly greater association with passive, shy behavior, poorer social skills, and decreased prosocial behavior as compared to hyperactive/impulsive symptoms, while hyperactive/impulsive symptoms have a significantly greater association with being disliked by peers (e.g. Willcutt et al., 2013, Willcutt et al., 2011; Huang-Pollock, Mikami, Pfiffner, & McBurnett, 2009; Reynolds & Kamphaus, 2004; DuPaul et al., 1998). The literature indicates that examining the nuances of social functioning may elucidate differential functioning between the symptom dimensions, and the proposed study is designed to capture these subtle aspects

of social performance. In this way, the current study will contribute to literature on the validity of the DSM-IV two dimension model.

ADHD-C vs. ADHD-I. The results of a recent meta-analysis show that ADHD-I is more strongly associated with passive and shy behavior than ADHD-C, even though, as the authors highlighted, one might expect similar associations due to similar levels of inattentive symptoms (Willcutt et al., 2012). ADHD-I has also been shown to be associated with impairment in assertiveness and increased deficits in social knowledge (e.g., Solanto & Alvir, 2009; Maedgen & Carlson, 2000). ADHD-C is associated with greater rejection by peers, overt aggression, relational aggression, impaired self-control, and emotional dysregulation (e.g., Solanto & Alvir, 2009; Hodgins et al., 2000; Zalecki & Hinshaw, 2004; Maedgen & Carlson, 2000).

ADHD-H. Few studies have examined ADHD-H due to the low base rate in the population (e.g. Willcutt, in press). Studies have been limited by the prevalence rates of ADHD-H and the subsequent decline in ADHD-H symptoms over time (e.g. Lahey et al., 2004; Greene et al., 1997), resulting in small sample sizes, especially for samples of adolescents and young adults. While the proposed study is similarly constrained, the anticipated sample is large enough to conduct exploratory analyses that may detect subtle differences between ADHD-H and other subtypes.

Specific Factors of Social Functioning

There are many components to successful social interaction, and it is unclear how they each contribute to result in social dysfunction. Children with ADHD are reported to be deficient in emotional face and prosody perception, and there is recent evidence for deficient theory of mind and empathy (e.g., Uekermann et al., 2010; Sinzig, Morsch, & Lehmkuhl, 2008; Boakes, Chapman, Houghton, & West, 2008; E. B. Braaten & Rosen, 2000). As previously reviewed, many studies have examined measures of overall social functioning, however, few have examined the subtle complexities of social functioning. In addition to examining commonly

studied broad measures such as number of friends and shy, passive behavior, the proposed study will examine less well-studied aspects of social function, such as empathy and aggression. Empathy and aggression, as well as executive function, have been proposed as potentially mediating the relationship between ADHD symptoms and social dysfunction (e.g. Huang-Pollock et al., 2009; Clark, Prior, & Kinsella, 2002).

Empathy. One component of social functioning is the ability to empathize with other individuals. There is controversy over the construct of empathy and there exist multiple definitions and terms used to describe empathy (see Batson, 2009 for review). It is described as part of larger constructs such as “theory of mind” (e.g. Uekermann et al., 2010), and as being a broader construct that consists of components such as “mindreading” or appropriate response to another person’s emotional state (e.g. Dziobek et al., 2008; Davis, 1980; Lawrence, Shaw, Baker, Baron-Cohen, & David, 2004). This study will conceptualize empathy as it has been in the psychopathology literature: as a construct consisting of both an affective component and a cognitive component (e.g., Baron-Cohen & Wheelwright, 2004; Davis, 1980; Dziobek et al., 2008).

Some studies have found that children with ADHD perform worse than comparison children on both cognitive and emotional empathy tasks (Yuill & Lyon, 2007; Braaten & Rosen, 2000). In one of the few studies directly assessing empathy and social perspective taking in ADHD, it was found that children with ADHD are rated as less empathic by their parents, but they do not rate themselves differently on empathy than do comparison children (Marton, Wiener, Rogers, Moore, & Tannock, 2009). Additionally, this study found that the difference between groups on parent rating was accounted for by comorbid conduct problems (Marton et al., 2009). Further research is needed to determine whether empathy is impaired in children with ADHD, and if there are unique additional factors, such as comorbid oppositional or conduct problems, that might better account for the impairment.

Aggression. Children with ADHD commonly exhibit decreased prosocial behavior and increased aggression relative to comparison children (e.g., Hoza, Gerdes, et al., 2005; Nijmeijer et al., 2008; Greene et al., 2001). Studies of overt vs. relational aggression in the developmental psychology literature have shown sex differences in these behaviors with girls more often engaging in relational aggression and boys more often engaging in physical aggression (e.g., Crick, 1996). In children with ADHD, this sex difference appears to hold true in at least one study that directly compares boys and girls (e.g., Abikoff, Jensen, Arnold, Hoza, & et al., 2002).

Compared with typically developing children, however, both boys and girls with ADHD displayed increased relational and overt aggression (e.g., Ohan & Johnston, 2007; Zalecki & Hinshaw, 2004). One of these studies demonstrated that the ADHD-C subtype was far more physically aggressive than the ADHD-I subtype, while they were more commensurate in impairment with regard to relational aggression (Zalecki & Hinshaw, 2004). Additionally, these results stayed significant after controlling for Conduct Disorder (Zalecki & Hinshaw, 2004). Another study found that girls with ADHD and comorbid ODD exhibited more overt and relational aggression and less prosocial behavior, while girls with ADHD only engaged in more awkward social interactions and demonstrated less covert aggression (Ohan & Johnston, 2007). Finally, at least one study has shown that increased aggression is associated with increased peer disapproval and a lower sociometric rating status (Hinshaw & Melnick, 1995). While aggression itself can be associated with poor social outcomes, it is unclear from the literature in what way this interacts with ADHD symptoms or whether the variance that ADHD symptoms account for beyond aggressive symptoms is clinically relevant.

Potential Moderators of Social Functioning in ADHD

Sex. The ratio of boys to girls with ADHD typically ranges from 4:1- 9:1 (APA, 1994). Though fewer girls experience ADHD symptoms, studies have shown that both genders express

similar levels of social deficits (e.g., Hartung et al., 2002; Greene et al., 2001; Gaub & Carlson, 1997). Girls and boys have similarly low peer social preference ratings (Hoza, Gerdes, et al., 2005), and at least one study has shown that there is no sex difference in the way that ADHD symptoms affect positive friendship quality (Glass et al., 2012).

However, examining various components of social function does reveal some sex differences in social performance. One study showed that social problems are more extreme for boys than girls (Pelham & Bender, 1982). Girls are more likely than boys to engage in verbal and relational aggression (Zalecki & Hinshaw, 2004). Additionally, studies show that girls demonstrating increased aggression or hyperactivity/impulsivity experience more peer rejection than their male counterparts (e.g., Diamantopoulou, Henricsson, & Rydell, 2005; Tseng et al., 2012). Authors of these studies hypothesize that this might be due to aggressive and impulsive behavior being perceived as gender non-normative for females and normative for males, especially for cultures with strictly defined gender roles (e.g. Diamantopoulou et al., 2005; Ohan & Johnston, 2005; Tseng et al., 2012).

Age. The literature generally shows similar association patterns between ADHD symptoms and social competence in studies with samples ranging from preschool through early adulthood (e.g., R. Barkley, Fischer, Smallish, & Fletcher, 2002; Hinshaw, Owens, Sami, & Fargeon, 2006; Juivez et al., 2011). Longitudinal studies have demonstrated that adolescents and young adults continue to experience social impairment (Sibley et al., 2010; Hinshaw et al., 2006; R. Barkley et al., 2002; Biederman et al., 1996). In a cross-sectional study with a sufficiently wide age range to use age as a predictor (5-16 years old), Booster et al. (2012) demonstrated that older children had more problems with social skills as measured by the BASC than younger children. However, this was only a small effect ($d=0.20$) and only for parent report. In a study of the relationship between ADHD symptoms and positive friendship quality by Glass et al. (2012), age was not a moderator. The latter study had a more restricted age

range, 11-17 years old. There might be a difference in the social functioning of children with ADHD pre- and post-puberty, however, the data is inconclusive at this time. Future studies including wider age ranges would allow for testing how age may be associated with impairment in social functioning.

Comorbid psychopathology. Children with ADHD have high rates of concurrent comorbid disorders, including oppositional defiant disorder, conduct disorder, mood disorders, anxiety disorders, and pervasive developmental disorders (e.g. Willcutt et al., 2012). The presence of an ADHD diagnosis comorbid with other disorders is associated with increased functional impairment, particularly social impairment (e.g. Abikoff et al., 2002; Mikami et al., 2011; Graziano et al., 2011; Rinsky & Hinshaw, 2011).

When comparing ADHD and comorbid internalizing or externalizing symptoms and disorders, the literature clearly supports that comorbid externalizing symptoms and disorders exacerbate social impairment, while the results are mixed for the effect of internalizing symptoms and disorders. In a large sample of clinically referred children, comorbid ADHD and disruptive behavior disorders resulted in increased rule-breaking, impulsive behavior, and aggressive behavior as compared to ADHD only or comorbid ADHD and anxiety (Abikoff et al., 2002). Children with comorbid ADHD and disruptive behavior disorders also demonstrated increased interference, off-task behavior, verbal aggression toward teachers, and total aggressive behavior as compared to children with ADHD only (Abikoff et al., 2002). In another clinic-referred sample, children with comorbid ADHD and externalizing symptoms displayed poorer social skills than those with ADHD alone (Booster et al., 2012). Yet another study found similar findings and determined that externalizing symptoms significantly predicted social impairment even after controlling for ADHD symptom severity (Graziano et al., 2011).

Results were somewhat mixed for internalizing symptoms and disorders. In the same study as previously described, Abikoff et al. (2002) found that there was no interaction of anxiety

and ADHD, specifically anxiety was not associated with behavioral suppression as was hypothesized. Another study with a clinic-referred sample also found no association between internalizing symptoms and social functioning (Graziano et al., 2011). However, a smaller study, also using a clinic-referred sample, found that anxiety did have a significant negative effect on social functioning (Solanto, Pope-Boyd, Tryon, & Stepak, 2009). Overall, these results suggest that comorbid disorders tend to increase social impairment.

Not only do comorbid disorders increase the impaired social function of children with ADHD, but increased social impairment in children with ADHD is associated with the development of comorbid disorders later in life (e.g. Greene & Ablon, 2001; McQuade et al., 2011). This cycle of escalating impairment underscores the importance of understanding the complexities of how ADHD and comorbid disorders contribute to social deficits in individuals with ADHD.

Current Study

The current study was designed to provide a comprehensive examination of social functioning in children and adolescents with ADHD and provide snapshots of their skills and abilities at various time points in development with the broader goal of laying the groundwork to begin to develop a profile of social functioning in ADHD that would assist with differential diagnosis and treatment planning for these children. While it is well established that children with ADHD exhibit social deficits, it is not clear what this looks like throughout development and there are aspects of social functioning that are not well studied in the ADHD literature. This study leveraged two previous large unselected samples of children that collected longitudinal data on ADHD symptoms and associated behaviors at two similarly spaced time points (~5 year follow up), and examined social functioning measured at these two time points. Then participants from these previous studies were recruited to participate in a third time point of data collection (~10 year follow up) where they were administered a novel battery of self-report

measures, including measures of social skills, friendship quality, empathy, theory of mind, and emotion regulation, many of which are infrequently used in studies of ADHD and have never been used all together in the same dataset. The primary aim at the third time point was to develop an increasingly nuanced characterization of children with ADHD and their ability to navigate the social world. The study will examine differential social functioning by subtype and symptom dimension, which also will add to the literature on validating the current structure of the ADHD diagnosis.

The specific aims of the study were to:

1) Systematically examine social functioning in children with ADHD by administering a comprehensive battery of parent-, teacher-, and self-report measures of global and specific aspects of social functioning.

1a: I hypothesized that children with ADHD will demonstrate worse performance on all measures of social functioning compared to typically developing children.

1b: Specifically, I anticipated that children with ADHD would be more likely to have an increase in social functioning related to the unique deficits in ADHD, e.g. higher ratings of reactive aggression due to impulsivity being a central feature of the disorder. For other measures, such as empathy, I hypothesized that this might be a smaller effect, since this is not a central deficit in ADHD, or that there would be a subset of children with ADHD who might demonstrate significant impairment in empathy (perhaps those more likely to have comorbid features of Autism Spectrum Disorder or Conduct Disorder).

2) Add to the literature examining the validity of DSM-IV ADHD by testing for differences between symptom dimensions in social functioning in children and adolescents.

Hypothesis 2a: I hypothesized that both dimensions would be associated with increased impairment on all measures of social functioning.

Hypothesis 2b: Based on findings in the literature, I anticipated that children with increased symptoms on the hyperactive/impulsive symptom dimension would exhibit greater impairment on measures of acceptance and rejection, parent ratings of being liked, and aggression, while children with increased impairment on inattentive symptoms will be more impaired on ratings of shyness and prosocial behavior.

3) Add to the literature examining the validity of DSM-IV ADHD by testing for differences between subtypes in social functioning in children and adolescents.

Hypothesis 3a: Based on findings in the literature, I anticipated the subtype findings would be consistent with what you might expect based on symptom dimensions, e.g. ADHD-I predicting more socially isolated and withdrawn behavior and being ignored by peers, and ADHD-H subtype predicting more aggressive behavior and peer rejection. I hypothesized that ADHD-C would demonstrate an additive effect of the two symptom dimensions for social outcomes associated with both types of symptoms, e.g. number of friends. For social outcomes more strongly associated with one symptom dimension over another, I hypothesized an underadditive effect for ADHD-C. For example, in the literature, inattention is more often associated with being ignored, thus this might be protective against being disliked by peers, because if one is ignored it may be less likely that they are actively disliked; therefore, ADHD-C might look more like ADHD-I on this measure.

4) Test whether ADHD symptoms are associated with significant social impairment after controlling for IQ, comorbid psychopathology, sex, and age.

Hypothesis 4a: I anticipated that IQ would be associated with many aspects of social functioning, particularly for social cognition, and that ADHD symptoms would still predict social dysfunction over and above any association with IQ.

Hypothesis 4b: I anticipated that internalizing and externalizing symptoms would be associated with poor social outcomes differentially such that internalizing symptoms would have

a stronger association with social isolation and withdrawal behaviors while externalizing symptoms would have a stronger association with aggression. I hypothesized that ADHD symptoms would continue to predict increased withdrawal and social isolation after controlling for comorbid internalizing symptoms. However, I hypothesized that ADHD symptoms may not remain significant predictors of aggressive behavior after controlling for externalizing symptoms.

Hypothesis 4c: Based on previous research, I hypothesized that females will score higher on empathy, and therefore deficits in females with ADHD may not be as noticeable as they will in males.

Hypothesis 4d: I hypothesized that ADHD symptoms would predict greater social impairment for older individuals. I expect this because greater sophistication is required to navigate social relationships as an adult than as a child.

6) An exploratory aim for this study is to compare ADHD symptoms and social functioning profiles measured at baseline and at follow up to determine predictive validity of symptom dimensions and social functioning.

Hypothesis 6a: Both inattentive and hyperactive/impulsive symptoms present early in life would predict social impairment later in life.

Hypothesis 6b: ADHD symptoms at initial testing will predict later social functioning even after controlling for social functioning at initial testing.

CHAPTER II

Method

Participants

Overview. To examine cross-sectional and longitudinal associations between ADHD and social functioning, this study leveraged data from two ongoing studies of the validity of DSM-IV ADHD. In both studies large unselected samples of children and adolescents in the

greater Denver, CO and Boulder, CO areas were screened, then a subset of participants with and without DSM-IV ADHD were invited to complete a follow-up assessment 5 - 10 years after the initial testing. The initial assessment in both studies included identical measures of ADHD symptoms and a range of measures of social functioning, and a streamlined set of measures of social functioning was included as part of the follow-up assessment for all participants. In addition, a new, more comprehensive battery of social measures was obtained in a targeted subset of the first sample. The remainder of this section briefly describes each sample and the procedures used to obtain the cross-sectional and longitudinal measures of social functioning that were used in the current thesis.

Sample #1. In the first sample, all parents of children in a random sample of schools from five local school districts were invited to participate in the initial phase of the study by filling out a packet of screening questionnaires (e.g., Willcutt, 2012; Willcutt, Boada, Riddle, Chhabildas, & Pennington, 2011). The screening included the four largest districts in the Denver/Boulder metropolitan area, with a specific focus on districts that included schools with a wider range of socioeconomic and racial and ethnic diversity. From an initial sample of approximately 13,000 families that were mailed the questionnaires, 8,450 families returned the screening materials to study research assistants. After parent questionnaires were received, parallel questionnaires were then sent to the teachers of those children whose families provided parental consent (final N with parent and teacher ratings = 7,382). Based on these parent and teacher ratings, a subset of families of children with and without DSM-IV ADHD were invited to participate in a more extensive individual testing session that included measures of intelligence and academic achievement, along with additional measures of social functioning.

For the current thesis, longitudinal analyses of sample 1 followed up two specific subgroups of the initial screening sample. The first subset of participants (N = 406) completed an abbreviated set of measures of social functioning (based on the key measures included in

this thesis) as part of a more extensive follow-up assessment of a range of functional outcomes that was completed 4 to 6 years after the initial assessment (mean span between assessments = 4.7 years). In addition, a much more comprehensive questionnaire regarding social functioning was completed by a smaller subset of individuals and their parents as part of the current thesis (N=66). The Time 3 follow-up assessment occurred 4 to 9 years after the initial assessment (mean span between assessments = 6.2 years). These new questionnaires provide one of the most comprehensive assessments of different dimensions of social functioning that has been collected in a sample of individuals with and without ADHD.

Sample #2. The second sample was a subset of the participants in the Colorado Learning Disabilities Research Center twin study (e.g., Wadsworth, DeFries, Olson, & Willcutt, 2007; Willcutt et al., 2007; Willcutt et al., 2010). Similar to the screening procedure for the community sample, all twins between 8 and 15 years old in 22 local school districts and their families were invited to participate. After parent consent was obtained, parents and teachers completed a set of screening questionnaires that included measures of DSM-IV ADHD and social functioning that were nearly identical to those included in the initial screening for sample #1. Based on the ADHD ratings obtained as part of the screening, pairs in which at least one twin met symptom criteria for DSM-IV ADHD and a comparison sample of pairs without ADHD were invited to participate in a more comprehensive assessment of learning and cognition that also included additional measures of social functioning (N=1789).

In a longitudinal follow-up procedure similar to the design of the sample #1, a subset of participants from the initial CLDRC study were invited to complete a follow-up assessment approximately five years after they completed the initial testing (e.g. Willcutt et al., 2007). The follow-up assessments occurred 4 to 7 years after the initial assessment (mean span between assessments = 5.2 years), and included key measures of social functioning along with a wide range of measures of cognitive, academic, and functional outcomes. As described in more

detail later in the Measures section, the majority of the social measures included in the follow-up battery were identical to those included at Time 1. In addition, Time 2 also included measures of key aspects of social functioning that were not covered in the initial follow-up of Time 1.

Rationale for inclusion of data from all available samples. Identical screening procedures were used to identify individuals with and without DSM-IV ADHD for the two studies, and the follow-up assessments were each completed approximately 5-10 years after the initial testing. Therefore, for measures of social functioning that were obtained in both studies, data from both samples were included in analyses to maximize statistical power for primary cross-sectional and longitudinal analyses. This increase in power was particularly important for questions in which sample sizes were smaller, such as ADHD subtypes, comparisons of males and females, and specific aspects of social functioning that were only measured in a subset of each sample.

Overall, the design for this thesis extends existing datasets to optimally address the cross-sectional and longitudinal aims of the current project. The measures of social functioning obtained as part of the initial screening assessments provided a large sample to address key cross-sectional questions regarding the relation between ADHD and social functioning. The longitudinal follow-up assessments then provided a more comprehensive appraisal of social functioning as children with ADHD reach early adolescence and emerging adulthood, a developmental period that has been less well studied than childhood (e.g. Willcutt et al., 2012).

Sample description. For the initial data collection, the male:female (M:F) sex ratio of the screened community sample was 1:1, but the majority of participants in the clinical groups were male (see Table 1) as is consistent with the prevalence of ADHD (Willcutt, 2012). The sample is also predominantly Caucasian (see Table 1), which is consistent with the ethnic population in the local area. The age of the children ranged from 5.1 – 22.2 years at Time 1, 11.0-20.8 years at Time 2, and 12.7-20.2 years at Time 3 (see Table 1).

Table 1

Description of samples

	Time 1	Time 2	Time 3
Sample size (N)	9171	685	66
Sex (% male)	50	57	47
Age in years M(SD)	9.7 (2.5)	14.5 (1.8)	16.0 (1.8)
Avg Parent Yrs of Education [M(SD)]	15.3 (2.7)	15.4 (2.4)	16.35 (3)
Full Scale IQ [M(SD)]	105 (14) ¹	106 (14) ²	105 (16) ³
Verbal IQ [M(SD)]	105 (16) ¹	107 (16) ²	106 (17) ³
Performance IQ [M(SD)]	105 (17) ¹	105 (18) ²	104 (18) ³
Ethnicity			
White	85.1%	87.4%	90.9%
Latino	14.1%	9.6%	24.2%
Black	13.7%	15.3%	16.7%
Asian	4.6%	3.5%	3.0%
Native	3.1%	3.8%	4.5%
Other	0.1%	0.0%	0.0%

¹n=5334, ²n=663, ³n=63

The ADHD-H subtype has a significantly lower base rate in the population and has been shown to be less stable over time with children originally meeting criteria for the subtype shifting to other diagnostic subtypes or losing their ADHD status altogether (e.g. Lahey, Pelham, Loney, Lee, & Willcutt, 2005). In a recent meta-analysis, Willcutt et al. (2012) demonstrated that 70% of children with an original diagnosis of ADHD-C continued to meet criteria for any type of ADHD at follow up in longitudinal studies, as did 50% of children with ADHD-I and 33% of children with ADHD-H. Due to the limited resources and time constraints for the third wave of data collection, we did not receive any surveys from individuals meeting criteria for ADHD-H. Thus, we were unable to run analyses by subtype at the third time point. See Table 2 and 3 for sample demographics by subtype for Time 1 and Time 2.

Table 2

Description of Time 1 sample by diagnostic group

	Total	Control	ADHD-I	ADHD-H	ADHD-C
Sample size	N=9171	n=7515	n=771	n=277	n=608
Sex (% male)	50.3	46.4	65.4	64.4	73.7
Age (years) [M(SD)]	9.7 (2.5)	9.6 (2.5) _a	10.5 (2.6) _b	8.9 (2.3) _c	9.5 (2.5) _a
Avg Parent Yrs of Ed [M(SD)]	15.3 (2.7)	15.3 (2.7) _a	15.3 (2.5) _a	15.0 (2.7) _{ab}	14.6 (2.5) _b
Full Scale IQ [M(SD)]	105 (14) ¹	106 (14) ² _a	100 (15) ³ _b	105 (16) ⁴ _a	99 (16) ⁵ _b
Verbal IQ [M(SD)]	105 (16) ¹	107 (16) ² _a	100 (16) ³ _b	106 (16) ⁴ _a	99 (18) ⁵ _b
Performance IQ [M(SD)]	105 (17) ¹	106 (17) ² _a	100 (18) ³ _b	104 (20) ⁴ _a	99 (19) ⁵ _b

Note. Means with no common subscripts are significantly different ($p < 0.01$).

¹n=5334, ²n=4206, ³n=540, ⁴n=194, ⁵n=394

Table 3

Description of Time 2 sample by diagnostic group

	Total	Control	ADHD-I	ADHD-H	ADHD-C
Sample size	N=685	n=543	n=77	n=14	n=51
Sex (% male)	56.6	52.6	66.7	85.7	76.5
Age (years) [M(SD)]	14.5 (1.8)	14.6 (1.8) _a	14.4 (1.7) _{ab}	13.3 (1.5) _{ab}	13.7 (1.8) _b
Avg. Parent Yrs of Ed [M(SD)]	15.4 (2.4)	15.4 (2.4)	15.3 (2.1)	16.6 (2.5)	15.0 (2.7)
Full Scale IQ [M(SD)]	106 (14) ¹	107 (13) ² _a	101 (14) ³ _b	115 (10) ⁴ _a	96 (17) ⁵ _b
Verbal IQ [M(SD)]	107 (16) ¹	108 (15) ² _a	102 (15) ³ _b	114 (11) ⁴ _a	98 (19) ⁵ _b
Performance IQ [M(SD)]	105 (18) ¹	107 (17) ² _a	100 (18) ³ _{bc}	115 (12) ⁴ _{ab}	94 (20) ⁵ _c

Note. Means with no common subscripts are significantly different ($p < 0.01$).

Note. Cognitive scores and parent years of education collected at Time 1.

¹n=663, ²n=526, ³n=74, ⁴n=13, ⁵n=50

Procedures

All study procedures have been continuously approved by the Institutional Review Board of the University of Colorado at Boulder. As described in the previous section, large samples of participants with and without DSM-IV ADHD completed the initial assessment for each study. Similar procedures were then used to identify and recruit participants for the longitudinal follow-up assessments used in the current thesis.

Follow-up procedures. To maximize the rate of participation in the longitudinal component of the studies, specific efforts have been made since the time of the initial testing to maintain updated contact information for the families (e.g., Wadsworth, 2007; Willcutt et al., 2012). In addition to requesting that families contact the study staff if they moved, families were sent regular newsletters, birthday cards, and other mailings. In addition to maintaining a positive relationship with each family, these mailings often provided a new forwarding address if a family had moved. If the latest available contact information was not correct despite these efforts, a series of procedures were implemented to attempt to find the family (all families gave consent for these procedures to be used). As a first step, study staff attempted to contact any individual that the family listed at the time of the initial assessment as someone who would know where they were in the future. If this was not successful, internet-based searches were implemented to attempt to find the new contact information for the family.

After completing all of these procedures it was possible to contact 70 - 75% of the families that initially participated in the study. When study staff were able to directly contact families, over 90% of the families that were contacted agreed to participate in the follow-up assessment. Nearly all of the small subset of families who declined to participate indicated that this was no longer possible (in a handful of cases the participant was deceased, was no longer in contact with the family, or had moved overseas for military service that precluded their

participation). Fewer than 5% of the families declined because they were no longer interested in participating in the study.

If a family agreed to participate in a follow-up assessment as part of the initial procedures for sample 1 and sample 2, all measures were completed in a single assessment session conducted at the University of Colorado at Boulder Institute for Behavioral Genetics. However, as noted earlier, the measures of social functioning obtained in these follow-up assessments were somewhat limited because the assessment batteries included a range of functional outcomes.

Therefore, a more comprehensive assessment of social functioning was obtained for the current thesis in a subset of the sample that participated previously in sample 1. These new measures were obtained entirely by mail. Families of previous participants with and without ADHD were first contacted to determine if they would be interested in participating in this latest follow-up assessment and to verify their current address. If a family agreed to participate, they were mailed the questionnaire packet of parent-report and self-report testing materials (described in detail in the subsequent section). Informed consent was obtained from the parent and assent or informed consent was obtained from the participant, and the questionnaires were returned to the study offices by mail. Each family received \$20 as partial compensation for their participation in this latest follow-up component of the study.

Measures

At all three time points, symptoms of ADHD were assessed via gold-standard parent and teacher report measures that are described in detail below and summarized in Table 4.

Table 4

Measure reliabilities and availability in each sample

	Sample 1			Sample 2		Reliability ^{a,b}
	Time 1	Time 2	Time 3	Time 1	Time 2	
ADHD Symptoms						
DBRS / BAARS-IV	P, T	P, T	P, S	P, T	P, T	0.72-0.95 ^a , 0.68-0.92 ^b
Prosocial Behaviors/Skills						
BASC: Social Skills	P	P	P			0.77 - 0.88 ^a
TASB: Prosocial	T	T				0.62 - 0.88 ^a
BASC: Leadership	P	P	P			0.81 - 0.86 ^b
Friendship						
DBRS / BAARS-IV:	P, T	P, T	P, S	P, T	P, T	0.78 ^b
Impairment w/ peers						
SRS: Like, Dislike	P, T			P, T		0.81 ^a , 0.63 ^b
Number of friends	P	P		P, S	P, S	0.55-0.70 ^b
Aggression						
BASC: Aggression	P	P	P	P	P	0.78 - 0.84 ^b
SRQ: Relational aggression	P	P	P			0.84 ^a , 0.68 ^b
TASB: Aggression	T	T				0.82 ^a , 0.72 ^b
YSR: Aggression	S			S		0.86 ^a , 0.88 ^b
RPAQ: Reactive, Proactive			S			0.83 ^a
Social Isolation						
BASC: Withdrawn	P	P	P	P	P	0.78 - 0.83 ^b
CLDQ: Social Isolation	P	P	P	P	P	0.52 - 0.63 ^a
SRS: Ignore	P, T	P, T	P	T	T	0.81 ^a , 0.63 ^b
TASB: Shy/withdrawn	T	T				0.84 ^a , 0.70 ^b
CSBQ: Withdrawn			P			0.85-0.90 ^a , 0.80-0.89 ^b
Loneliness Scale	S	S	S			0.84-0.88 ^a , 0.55-0.69 ^b
UCLA Loneliness			S			0.89-0.94 ^a , 0.73 ^b

^aCronbach's alpha, ^btest-retest reliability

Global measures of social functioning collected at Time 1 and 2 were selected to provide an initial overview of social functioning that covered a broad array of constructs, including social skills, friendship and peer relationships, aggressive behavior, withdrawal, and social cognition. For the current thesis, a comprehensive battery of social measures at Time 3 was constructed to include measures of broad social functioning used at the initial data collection and commonly used in previous studies of ADHD along with measures of more specific social constructs that have been used less often in the ADHD literature, but have been shown to be relevant to social functioning in the developmental and psychopathology literatures (e.g. Crick, 1996; Baron-Cohen & Wheelwright, 2004; P. J. Frick & White, 2008). When multiple theoretically equivalent measures were available, measures that were administered in previous waves of the study, most reliable, and approximately normally distributed in the targeted age range were prioritized. Measures selected utilized both parent- and self-report for key domains including ADHD symptoms, overall social functioning, social isolation, empathy, and aggression. This decision was based on previous data suggesting that multi-informant methods provide the most accurate picture of social functioning (e.g. Tackett & Ostrov, 2010; Hoza, 2007). In addition to providing the benefits of multiple measures of each construct, each informant may potentially have a unique perspective on a construct (e.g. Hoza, 2007). For example, self- and parent-report measures of social isolation were chosen, because theoretically there are aspects such as the experience of loneliness, that might be outside the parent's awareness. Since the primary focus of the initial data collection at Time 1 and Time 2 was not social functioning, incorporation of the various social measures was inconsistent and less comprehensive than at the Time 3 follow up. Please refer to Table 4 to determine in which sample and at which time point each measure was administered. Table 4 also includes reliability data for all measures used in the study.

ADHD symptoms. The Disruptive Behavior Rating Scale (DBRS; R. A. Barkley, 1998) was used to obtain parent ratings of DSM-IV ADHD symptoms. The DBRS uses a four-point

scale on which each symptom is rated as “never or rarely”, “sometimes,” “often”, or “very often.” Items rated as “often” or “very often” are scored as positive symptoms (e.g. Pelham, Gnagy, Greenslade, & Milich, 1992; Pelham et al., 1992). Ratings on the DBRS are internally consistent ($\alpha = 0.92-0.96$) and have acceptable test-retest reliability ($r = 0.78-0.89$; e.g. Friedman-Weieneth, Doctoroff, Harvey, & Goldstein, 2009).

ADHD status in the initial two waves of data collection was determined based on parent and teacher ratings combined using the ‘or rule’ procedure from the DSM-IV field trials (e.g. Lahey et al., 1994). This algorithm counts each ADHD symptom as positive if either the parent or teacher has rated it positively (e.g., Piacentini, Cohen, & Cohen, 1992). Children with six or more inattention symptoms and six or more hyperactive/impulsive symptoms were categorized as combined type, children with six or more inattention symptoms but fewer than six hyperactive/impulsive symptoms were categorized as predominantly inattentive type, and children with six or more hyperactive/impulsive symptoms but fewer than six inattention symptoms were categorized as predominantly hyperactive/impulsive type.

Although initial ADHD status was based on parent and teacher ratings, our research group and others have encountered increasing difficulty obtaining permission from schools to obtain teacher ratings, and this has been particularly problematic for students in middle school or high school. Considering the low response rate of previous studies and the time and cost constraints of the third wave of data collection, it was not feasible to invest the resources required to obtain teacher ratings. Further, it is much more difficult to interpret the results of teacher ratings, or select one particular teacher to complete the ratings, once adolescents attend 6-7 different classes in junior and senior high school. Instead, we obtained self-report ratings of ADHD symptoms with the Barkley Adult ADHD Rating Scale-IV (BAARS-IV; R. A. Barkley, 2011) to provide a secondary source of information regarding ADHD symptoms.

Parallel to the procedure used to combine parent and teacher ratings at the initial assessment, parent- and self-reports were combined using the 'or-rule' to create summary scores for the ADHD symptom dimensions and subtypes at the time of the latest comprehensive assessment of social functioning. Because the aims of the current study focus on social impairment associated with ADHD, the DSM-IV criterion requiring significant impairment was not used to classify participants with ADHD.

Social functioning.

Prosocial Behavior/Social Skills.

Behavior Assessment Scale for Children-II. Parents completed the Behavior Assessment Scale for Children-II (BASC-II; Reynolds & Kamphaus, 2004), which is a standardized measure of psychopathology that broadly assesses internalizing and externalizing symptoms and other psychopathology. In addition to scales designed to assess symptoms of psychopathology, the BASC-II includes a set of measures designed to assess functional impairment that may be associated with psychopathology. The Social Skills and Leadership scales were used for measures of prosocial behaviors. These scales have moderate to high reliability (Reynolds & Kamphaus, 2004).

Teacher Assessment of Social Behavior. The Teacher Assessment of Social Behavior (TASB; Cassidy & Asher, 1992) is a rating scale completed by the child's teacher assessing the child's current social functioning. The internal consistency of all four scales is adequate to high ($\alpha = 0.62$ for shy/withdrawn, $\alpha = 0.88$ or higher for prosocial, aggressive, and disruptive), and positive correlations with socio-metric ratings by peers support the validity of the TASB (Cassidy & Asher, 1992).

Friendship.

Disruptive Behavior Rating Scale. The Disruptive Behavior Rating Scale (DBRS; R. A. Barkley & Murphy, 1998) includes several items that assess impairment by asking parents or

teachers to rate the extent to which the child's ADHD symptoms interfere with social interactions with peers and adults, and the parent-report and self-report versions of the BAARS-IV includes parallel items assessing overall social impairment. Items on all of these measures are reported to be highly reliable (R. A. Barkley & Murphy, 1998).

Sociometric rating scale. The child's parent completed a socio-metric rating scale to estimate the proportion of children in the classroom who "like", "dislike", or "ignore" the child, using the procedures outlined by Dishion (1990) and later adapted for the DSM-IV field trials for the disruptive behavior disorders (e.g. Gaub & Carlson, 1997; Lahey et al., 1994). Earlier analyses in the initial sample indicate that the scale has adequate 1-year test-retest reliability.

Parent report of friendship. To provide a final source of corroborating information regarding friendships, parents of participants were asked the following questions:

How many friends does your child have? How many times per week does your child spend time with friends? These are face valid questions our research group used in previous studies, and all have adequate test-retest reliability over a period of approximately one year (Willcutt, Boada, Riddle, Chhabildas, DeFries, et al., 2011).

Social Isolation.

Loneliness Scale. Each participant completed this self-report instrument designed to assess the participant's ability to make and keep friends, as well as the extent that they feel left out of peer activities (Cassidy & Asher, 1992). In the original study of the measure, children and adolescents with low ratings of social acceptance by peers scored significantly lower on this measure than average or highly accepted children. Moreover, individuals with the lowest friendship scores were rated as less prosocial and more shy and aggressive by teachers and peers. Earlier analyses in the initial sample indicate that the scale has adequate 1-year test-retest reliability.

Revised UCLA Loneliness Scale. The Revised UCLA Loneliness Scale (R-UCLA) is a 20-item self-report scale that provides information regarding the subjective experience of feeling alone with 10 reverse scored items (Russell, Peplau, & Cutrona, 1980). Positive valence items include, “I feel in tune with people around me” and “There are people who really understand me.” Negative valence items include, “My social relationships are superficial” and “I feel left out.” In adults, this measure is reliable and valid (Russell, Peplau, & Cutrona, 1980). We computed internal consistency for this measure in our sample and it was solid ($\alpha = 0.86$).

Empathy measures. Measures of empathy were chosen to reflect the affective and cognitive components proposed in the literature (Batson, 2009). To do this, some measures will be deconstructed into subscales that are designed to capture these two different types of empathic ability as described below.

Empathy and Systemizing Quotient. The Empathy and Systemizing Quotient (ESQ; Auyeung et al., 2009) is a version of the Empathy Quotient (EQ) and Systemizing Quotient (SQ) adult questionnaires (Baron-Cohen, Richler, Bisarya, Guranathan, & Wheelwright, 2003; Baron-Cohen & Wheelwright, 2004) that is adapted for children. The ESQ is a 55-item parent-report questionnaire that can be split into two subscales, one for empathy and one for systemizing. Participants’ parents rate items on a 4-point Likert scale from “definitely agree” to “definitely disagree.” For the purposes of our study, we will only administer the 28 items from the empathy subscale. This scale corresponds to the adult EQ, and the authors of the measure report that the empathy subscale of the ESQ has good reliability (Auyeung et al., 2009).

Interpersonal Reactivity Index. The Interpersonal Reactivity Index (IRI; Davis, 1980) is a 28-item multi-dimensional self-report measure of empathy. The IRI consists of 4 subscales: perspective-taking, fantasy, empathic concern, and personal distress. The author of the scale explains that the perspective-taking subscale is intended to assess the cognitive component of empathy, while the empathic concern subscale is intended to assess the affective component of

empathy. We computed internal consistency for these subscales in our sample and our data supported the current structure (perspective taking $\alpha=0.78$; empathic concern $\alpha=0.81$; personal distress $\alpha=0.82$). The personal distress subscale is designed to distinguish between affective empathy that is associated with an emotional focus on the other person, whereas the personal distress subscale is designed to capture a more self-focused reaction to another person's distress by thinking thoughts like, "What if it happened to me?" The fantasy subscale is attempting to assess imaginal empathy for characters in books or movies. Other researchers have commented that the fantasy subscale is capturing extraneous aspects of social functioning that might be related to empathy, but that do not necessarily make up the empathy construct itself (Baron-Cohen & Wheelwright, 2004). Therefore, this study will focus analyses on the other three subscales. Participants rate items on a 5-point Likert scale from "does not describe me well" to "describes me very well." The IRI scales have moderate to good reliability (Davis, 1980).

Colorado Learning Difficulties Questionnaire. The Colorado Learning Difficulties Questionnaire (CLDQ; Willcutt et al., 2011) is a 20 item parent-screening measure that briefly screens for learning difficulties in the following areas: reading, math, social cognition, social anxiety, and spatial difficulties. For the purposes of this study, the social cognition scale will be analyzed as a primary outcome measure. This scale has adequate reliability (Willcutt et al., 2011).

Children's Social Behavior Questionnaire. The Children's Social Behavior Questionnaire (CSBQ; Hartman, Luteijn, Serra, & Minderaa, 2006) is a 48-item parent-report measure of the broad impairments often seen in children with a Pervasive Developmental Disorder (PDD). This scale is particularly relevant because PDD has been described as an "empathy disorder" (Gillberg, 1992) and there is a growing body of research demonstrating that subclinical features of PDD are commonly present in children with ADHD (e.g. Reiersen & Todd, 2008). There are

six subscales comprised of items meeting the following criteria: 1) “not optimally tuned to the social situation,” 2) “reduced contact and social interest,” 3) “orientation problems in time, place, or activity,” 4) “difficulties in understanding social information,” 5) “stereotyped behavior,” and 6) “fear of and resistance to changes” (Hartman et al., 2006). Three of the subscales (not tuned to social situation, reduced social contact, and difficulty understanding social information) are specific to the social aspects of PDD, and these are the subscales that will be used. Per the developers, this measure has high reliability and adequate internal consistency (Hartman et al., 2006). However, a factor analysis in our sample only provided moderate support for this factor structure.

Antisocial Process Screening Device. The Antisocial Process Screening Device (APSD; P.J. Frick & Hare, 2001) is a 20-item parent report measure that provides scores on three subscales: callous/unemotional traits, narcissism, and impulsivity. The purpose of this measure is to assess psychopathy, which is often viewed as the absence of affective empathy even when cognitive empathy may be intact (e.g. P. J. Frick & White, 2008). The 6-item callous/unemotional subscale is most relevant to the construct of empathy with items such as, “does not show feelings or emotions,” and “is concerned about the feelings of others.” Thus, this scale will be a primary outcome measure for our analyses. The callous/unemotional scale has moderate to high reliability (see Table 4; P.J. Frick & Hare, 2001), and initial analyses in both of the samples used for this project indicate that the callous/unemotional items load on a factor separate from the other ASPD items.

Aggression.

Reactive-Proactive Aggression Questionnaire. The Reactive-Proactive Aggression Questionnaire (RPQ; Raine et al., 2006) is a 23 item self-report questionnaire developed to assess for the presence of different types of aggression. Items on this measure assessing proactive aggression include, “Had fights with others to show who was on top,” and “Gotten

others to gang up on someone else.” Items measuring reactive aggression include, “Gotten angry when frustrated,” and “Felt better after hitting or yelling at someone.” Items are rated on a 3-point Likert scale from “never” to “often.” The youth-self-report version of the RPQ is reliable and valid as evidenced by correlations with several well-established measures of hostility, delinquency, sensation-seeking, impulsivity, and trait anxiety (Raine et al., 2006).

Social Relations Questionnaire. The Social Relations Questionnaire (SRQ; Lahey et al., 2004) is a 7-item questionnaire assessing relational aggression with a parent-report version. Items include questions about teasing other children in a mean way, spreading rumors about other children s/he does not like, and writing critical notes about other children. Items are rated on a 4-point Likert scale from “not at all” to “very much.” The SRQ is considered to be reliable (Tackett et al., 2009).

Comorbid Psychopathology.

BASC-II. The same measure of comorbid psychopathology was used as in the initial study: BASC-II. The BASC-II assesses for externalizing and internalizing symptoms and other potential comorbid difficulties, and it is a reliable measure (Reynolds & Kamphaus, 2004).

Childhood Behavior Checklist. The Childhood Behavior Checklist from the Achenbach System of Empirically Based Assessment (CBCL, ASEBA; Achenbach & Rescorla, 2001) is a measure that assesses for a broad array of behaviors and provides DSM-IV oriented and syndrome scales, such as withdrawn/depressed and oppositional defiant problems. This measure was administered in sample #2.

Intellectual Functioning. Cognitive ability was estimated by extrapolating an estimate of Full Scale IQ from Vocabulary and Block Design as measured by the Wechsler Intelligence Scale for Children- 4th Edition (WISC-IV; Wechsler, 2003).

Data Analyses

Data preparation. Prior to all analyses, the distribution of each variable was assessed for outliers. Outliers were defined as scores more than three standard deviations (SD) from the mean of the sample and more than 0.5 SD beyond the score just previous. After verifying that the outlying value was scored correctly, the score was considered for removal or adjustment. No outliers were removed as all were appropriate for adjustment, and they were adjusted to a score 0.5 SD beyond the next highest or lowest score, with multiple outliers rescored to 0.1 SD apart. In addition, the distribution of each variable was assessed for normality and a logarithmic transformation, using a natural logarithm, was implemented to approximate a normal distribution in the case of variables with skewness or kurtosis greater than one. Due to the nature of psychopathology, which is by definition observation of the extreme end of a spectrum of behavior, several measures continued to have a skewness or kurtosis score greater than 1 even after the transformation.

Age was not significantly correlated with many measures of social functioning. However, the significant correlations were such that children generally improve as they mature. For measures that were correlated with age, the dependent variable was regressed onto age and the residual score was saved to create an age-adjusted variable.

Covariates. For all of the models, IQ, sex, and comorbid psychopathology are potential covariates. The covariates will be tailored to each dependent variable, such that models will include only covariates that are significantly associated with the dependent variable. Some researchers argue that IQ should also be statistically controlled to ensure that functional impairments associated with ADHD cannot be explained better by group differences in intelligence (e.g., Lahey et al., 1998; Werry, Elkind, & Reeves, 1987). Other researchers point out that attentional difficulties may directly cause a child to perform poorly on tests of intelligence (e.g., R. A. Barkley, 1997), in which case controlling for IQ would be overly stringent. These issues have not been conclusively resolved, therefore, we will run all models

of social functioning with and without controlling IQ. Due to the high number of statistical tests, an alpha of .01 will be adopted as the threshold for statistical significance, and *p*-values between .05 and .01 will be described as marginally significant.

Dimensional analyses. As an initial test of concurrent validity, Pearson correlations were computed between each symptom dimension and measures of social functioning. When the zero-order correlations with the inattentive and/or hyperactive/impulsive scales were significant, a more stringent test of the concurrent and discriminant validity of the dimensions was completed by conducting multiple regression analyses. Multiple regression models were constructed with inattention and hyperactivity/impulsivity included as independent predictors, and these models were fitted to test whether the inattentive or hyperactive/impulsive symptom dimensions account for unique variance in each social functioning measure. After completing the analyses of each social functioning measure separately, relevant covariates were added to the model to test whether the social dysfunction associated with ADHD was better accounted for by intellectual functioning or symptoms of commonly comorbid disorders. Sex was added to the model as an additional predictor to test for any differences in the relationship between ADHD symptoms and social functioning by sex. Further, the sample was stratified by sex and multiple regressions were again conducted to illustrate potential differences in the pattern of results by sex.

Subtype comparisons. Analyses of variance (ANOVA) were used to compare ADHD subtypes and the comparison group without ADHD. When the initial ANOVA revealed a significant main effect of group, we conducted Bonferroni post-hoc comparisons among the four groups with the significance level adjusted to 0.01 due to the large number of tests to analyze all measures.

Predictive validity. Finally, multiple regression models were used to test whether ADHD symptoms at initial testing predict social functioning at later testing.

CHAPTER III

Results

ADHD symptoms and social functioning were measured at three different time points to allow for cross-sectional analyses of ADHD symptoms and their relationship to social functioning at various time points across development. Further, slightly different measures of social functioning were collected at each time point, and the measures used at Time 3 were specifically selected to provide a more nuanced assessment of social functioning.

These cross-sectional analyses will be presented first for each aspect of social functioning. Correlations, regressions, and diagnostic subtype comparisons will be presented for all three time points when possible. When comparing diagnostic groups, however, there was only a sufficient sample to conduct contrasts with ADHD-H at Time 1, and the sample size at Time 3 was too small to run any diagnostic subtype comparisons. Therefore, only comparisons for ADHD-C and ADHD-I will be presented for Time 2, and subtype comparisons were not completed for Time 3. In addition to the primary cross-sectional analyses, exploratory longitudinal analyses were completed to provide preliminary data regarding the developmental course of the relation between ADHD and social functioning. The advantage of having a cohort of individuals followed over time is the opportunity to assess the predictive validity of ADHD symptoms and subtypes at Time 1 with respect to social functioning at Time 2. Further, although the Time 3 sample does not have a sufficient number of participants to conduct full longitudinal analyses across all three time points, multiple regression analyses were conducted to provide an initial examination of the extent to which Time 1 ADHD symptoms predicted the more nuanced measures of social functioning obtained at Time 3.

Prosocial Behavior and Social Skills

Parent- and teacher-rated measures of prosocial behavior and social skills at Time 1 and 2 were inversely correlated with inattentive and hyperactive/impulsive symptoms, and these correlations were generally similar in magnitude (for all Pearson r values cited in this section, see Tables 5, 6, & 7).

Table 5

Time 1: Current symptoms of inattention and hyperactivity/impulsivity ('or-rule') and associated impairment in social functioning

Zero-order Correlations				Multiple Regressions							
Measures (rater)	N	Inatt	Hyp/Imp	Inatt		Hyp/Imp		Interaction		Model	
				<i>B</i>	<i>95% CI</i>	<i>B</i>	<i>95% CI</i>	<i>B</i>	<i>95% CI</i>	<i>R</i> ²	<i>F</i>
Prosocial Behaviors/Skills											
BASC: Social skills (p)	3114	-0.41*	-0.37*	-0.30*	[-0.35, -0.26]	-0.10* ^{dg}	[-0.15, -0.05]	-0.04 ^h	[-0.07, -0.01]	0.18	225.69*
TASB: Prosocial (t)	3521	-0.51*	-0.49*	-0.31*	[-0.35, -0.27]	-0.19* ^d	[-0.24, -0.15]	-0.04*	[-0.07, -0.02]	0.28	463.36*
BASC: Leadership (p)	2097	-0.45*	-0.29*	-0.53*	[-0.58, -0.47]	0.13*	[0.07, 0.19]			0.21	280.72*
Friendship											
DBRS: Imp. with peers (p)	8679	0.46*	0.48*	0.25*	[0.22, 0.27]	0.27*	[0.24, 0.29]	0.07*	[0.06, 0.09]	0.26	1015.63*
DBRS: Imp. with peers (t)	7382	0.59*	0.55*	0.39*	[0.36, 0.42]	0.22*	[0.19, 0.24]	0.10*	[0.08, 0.12]	0.39	1567.57*
SRS: Like (p)	6499	-0.30*	-0.29*	-0.19*	[-0.22, -0.16]	-0.10* ^h	[-0.14, -0.06]	0.09*	[-0.11, -0.07]	0.11	255.46*
SRS: Like (t)	6167	-0.43*	-0.39*	-0.31*	[-0.34, -0.28]	-0.09* ^{dhk}	[-0.12, -0.05]	-0.11*	[-0.13, -0.09]	0.21	556.25*
SRS: Dislike (p)	6469	0.29*	0.29*	0.17*	[0.13, 0.20]	0.11* ^d	[0.08, 0.15]	0.11*	[0.09, 0.13]	0.11	269.02*
SRS: Dislike (t)	6161	0.37*	0.38*	0.20*	[0.16, 0.23]	0.15* ^{dh}	[0.11, 0.18]	0.13*	[0.11, 0.15]	0.18	437.33*
Number of friends (p)	5489	-0.23*	-0.22*	-0.15*	[-0.19, -0.12]	-0.08* ^{adj}	[-0.12, -0.04]	-0.04* ^d	[-0.07, -0.02]	0.06	117.86*
Aggression											
BASC: Aggression (p)	3117	0.42*	0.50*	0.10* ^g	[0.06, 0.15]	0.40*	[0.35, 0.44]			0.25	519.43*
SRQ: Relational agg. (p)	4903	0.31*	0.39*	0.04 ^{hadj}	[0.00, 0.08]	0.33*	[0.30, 0.37]			0.15	426.71*
TASB: Aggression (t)	3519	0.43*	0.51*	0.06* ^{adj}	[0.01, 0.10]	0.39*	[0.35, 0.44]	0.07*	[0.05, 0.10]	0.27	435.48*
YSR: Aggression (s)	406	0.21*	0.23*	0.13 ^{hadj}	[0.01, 0.25]	0.17* ^{dhk}	[0.04, 0.31]			0.06	14.07*

Table 5

Time 1: Current symptoms of inattention and hyperactivity/impulsivity ('or-rule') and associated impairment in social functioning

Social Isolation											
BASC: Withdrawn (p)	3118	0.23*	0.14*	0.26*	[0.21, 0.31]	-0.06 ^{*fll}	[-0.11, -0.01]			0.05	85.58*
CLDQ: Social Isolation (p)	5966	0.40*	0.32*	0.36*	[0.32, 0.39]	0.03 ⁱ	[-0.01, 0.07]	0.04 ^{*bhc}	[0.01, 0.06]	0.16	388.08*
SRS: Ignore (p)	6458	0.28*	0.23*	0.24*	[0.21, 0.28]	0.02	[-0.02, 0.06]	0.05 ^{*b}	[0.03, 0.07]	0.08	189.26*
SRS: Ignore (t)	6170	0.37*	0.27*	0.37*	[0.34, 0.40]	-0.05 ^{*gj}	[-0.08, -0.01]	0.05 ^{*gj}	[0.03, 0.07]	0.14	336.38*
TASB: Shy/withdrawn (t)	3521	0.34*	0.19*	0.48*	[0.44, 0.53]	-0.21*	[-0.25, -0.16]			0.14	275.73*
YSR: Withdrawn (s)	406	0.13*	-0.03	0.26*	[0.14, 0.38]	-0.20*	[-0.33, -0.07]			0.04	9.11*
Loneliness Scale (s)	623	0.23*	0.17*	0.25*	[0.13, 0.37]	-0.03	[-0.14, 0.09]			0.05	18.04*
Cognitive Empathy											
CLDQ: Social Cognition (p)	5966	0.57*	0.57*	0.33*	[0.30, 0.36]	0.28*	[0.25, 0.31]	0.08*	[0.06, 0.10]	0.39	1259.86*
Affective Empathy											
APSD: Callous (p)	2487	0.31*	0.29*	0.19*	[0.14, 0.25]	0.13 ^{*d}	[0.08, 0.18]			0.10	138.49*
APSD: Narcissism (p)	2487	0.35*	0.40*	0.12 ^{*g}	[0.07, 0.17]	0.35*	[0.29, 0.40]	-0.08*	[-0.11, -0.04]	0.17	174.35*
Other Social											
DBRS: Imp. with adults (p)	8681	0.49*	0.48*	0.31*	[0.28, 0.33]	0.23*	[0.20, 0.26]	0.07*	[0.05, 0.09]	0.28	1108.17*
DBRS: Imp. with teacher (t)	7380	0.61*	0.55*	0.44*	[0.42, 0.47]	0.17*	[0.14, 0.20]	0.11*	[0.09, 0.12]	0.41	1696.21*
DBRS: Imp. with staff (t)	7372	0.58*	0.55*	0.39*	[0.36, 0.41]	0.19*	[0.16, 0.22]	0.15*	[0.13, 0.17]	0.39	1566.15*
YSR: Social Problems (s)	406	0.27*	0.11*	0.34*	[0.22, 0.46]	-0.09	[-0.21, 0.04]			0.08	19.43*

Table 5

Time 1: Current symptoms of inattention and hyperactivity/impulsivity ('or-rule') and associated impairment in social functioning

Note. Only significant interactions reported, otherwise the model without the interaction is presented.

* $p < 0.01$, $^{\wedge}p = 0.01-0.05$ (2-tailed).

^aEffect no longer significant after controlling for IQ, ^bEffect became marginally significant after controlling for IQ, ^cEffect became significant after controlling for IQ, ^dEffect no longer significant after controlling for symptoms of ODD, ^eEffect became marginally significant after controlling for symptoms of ODD, ^fEffect became significant after controlling for symptoms of ODD, ^gEffect no longer significant after controlling for symptoms of depression, ^hEffect became marginally significant after controlling for symptoms of depression, ⁱEffect became significant after controlling for symptoms of depression, ^jEffect no longer significant after controlling for symptoms of anxiety, ^kEffect became marginally significant after controlling for symptoms of anxiety, ^lEffect became significant after controlling for symptoms of anxiety.

Table 6

Time 2: Current symptoms of inattention and hyperactivity/impulsivity ('or-rule') and associated impairment in social functioning

Zero-order										
Correlations				Multiple Regressions						
Measures (rater)	N	Inatt	Hyp/Imp	Inatt		Hyp/Imp		Interaction		Model
				<i>B</i>	95% <i>CI</i>	<i>B</i>	95% <i>CI</i>	<i>B</i>	95% <i>CI</i>	<i>R</i> ² <i>F</i>
Prosocial Behaviors/Skills										
BASC: Social Skills (p)	685	-0.49*	-0.42*	-0.41*	[-0.51, -0.31]	-0.11 ^{ag}	[-0.21, -0.01]			0.25 112.55*
TASB: Prosocial (t)	248	-0.54*	-0.45*	-0.47*	[-0.63, -0.30]	-0.07	[-0.23, 0.80]			0.30 51.82*
BASC: Leadership (p)	402	-0.52*	-0.36*	-0.61*	[-0.75, -0.48]	0.12	[-0.01, 0.24]			0.28 75.67*
Friendship										
DBRS: Imp. with peers (p)	685	0.57*	0.61*	0.27*	[0.18, 0.36]	0.37*	[0.27, 0.47]	0.07 ^g	[0.01, 0.14]	0.40 151.79*
DBRS: Imp. with peers (t)	411	0.58*	0.55*	0.37*	[0.24, 0.48]	0.25 ^e	[0.13, 0.37]			0.36 114.33*
SRS: Like (p)	406	-0.40*	-0.40*	-0.23 ^h	[-0.37, -0.09]	-0.20 ^h	[-0.34, -0.07]			0.18 43.84*
SRS: Like (t)	421	-0.45*	-0.44*	-0.29*	[-0.43, -0.16]	-0.12	[-0.27, -0.02]	-0.12 ^d	[-0.21, -0.03]	0.24 42.99*
SRS: Dislike (p)	406	0.34*	0.35*	0.17 ^{ag}	[0.02, 0.31]	0.21 ^{bg}	[0.07, 0.35]			0.13 31.19*
SRS: Dislike (t)	421	0.36*	0.37*	0.17 ^{dh}	[0.03, 0.30]	0.23 ^{dh}	[0.09, 0.36]			0.15 36.85*
Number of friends (p)	685	-0.15*	-0.12*	-0.14 ^a	[-0.25, -0.02]	-0.01	[-0.13, 0.10]			0.02 7.49*

Table 6

Time 2: Current symptoms of inattention and hyperactivity/impulsivity ('or-rule') and associated impairment in social functioning

Aggression										
BASC: Aggression (p)	685	0.52*	0.57*	0.21 ^{*dg}	[0.11, 0.30]	0.41*	[0.32, 0.50]		0.34	176.24*
SRQ: Relational agg. (p)	319	0.30*	0.33*	0.10	[-0.07, 0.26]	0.24 ^{*dh}	[0.08, 0.39]		0.12	20.48*
TASB: Aggression (t)	249	0.49*	0.56*	0.16 ^{^d}	[0.00, 0.32]	0.29*	[0.11, 0.46]	0.14 ^{*d}	[0.04, 0.25]	0.34 41.49*
YSR: Aggression (s)	237	0.20*	0.29*	-0.02	[-0.21, 0.17]	0.35*	[0.15, 0.55]		0.09	10.12*
Social Isolation										
BASC: Withdrawn (p)	685	0.33*	0.23*	0.38*	[0.27, 0.49]	-0.06 ^{el}	[-0.17, 0.05]		0.11	42.44*
CLDQ: Social Isolation (p)	406	0.50*	0.46*	0.37*	[0.23, 0.50]	0.16 ^{^dg}	[0.04, 0.29]		0.26	72.38*
SRS: Ignore (p)	406	0.35*	0.28*	0.34*	[0.19, 0.48]	0.02	[-0.12, 0.16]		0.13	28.96*
SRS: Ignore (t)	421	0.38*	0.31*	0.34*	[0.20, 0.48]	0.04	[-0.10, 0.18]		0.15	35.75*
TASB: Shy/withdrawn (t)	248	0.24*	0.09	0.40*	[0.22, 0.59]	-0.21 [^]	[-0.39, -0.04]		0.08	10.27*
YSR: Withdrawn (s)	237	0.09	0.12							
Loneliness Scale (s)	179	0.27*	0.20*	0.29 ^{^a}	[0.06, 0.52]	-0.03	[-0.24, 0.18]		0.07	6.86*
Cognitive Empathy										
CLDQ: Social Cognition (p)	406	0.64*	0.70*	0.25*	[0.14, 0.36]	0.42 ^{*d}	[0.30, 0.53]	0.08 ^{^d}	[0.01, 0.15]	0.52 142.21*
CLDQ: Social Cognition (t)	245	0.56*	0.53*	0.36*	[0.20, 0.52]	0.13	[-0.05, 0.30]	0.14 ^{^d}	[0.03, 0.25]	0.35 44.00*
Affective Empathy										
APSD: Callous (p)	273	0.36*	0.31*	0.30 ^{*dh}	[0.12, 0.47]	0.07	[-0.10, 0.24]		0.13	20.48*
APSD: Narcissism (p)	273	0.50*	0.53*	0.21 ^{^dg}	[0.05, 0.36]	0.36 ^{*d}	[0.20, 0.51]		0.30	58.24*

Table 6

Time 2: Current symptoms of inattention and hyperactivity/impulsivity ('or-rule') and associated impairment in social functioning

Family Relationships											
CBCL: Get along/family (p)	279	-0.23*	-0.20*	-0.25* ^{dg}	[-0.43, -0.08]	0.00	[-0.20, 0.20]	-0.18* ^d	[-0.33, -0.03]	0.07	7.28*
YSR: Get along/family (s)	235	-0.12	-0.05								
CBCL: Get along/sibling (p)	279	-0.25*	-0.19*	-0.25* ^g	[-0.42, -0.08]	-0.04	[-0.23, 0.15]			0.06	9.50*
YSR: Get along/sibling (s)	234	-0.20*	-0.14 [^]	-0.27* ^{dh}	[-0.46, -0.07]	0.10	[-0.12, 0.31]	-0.21* ^d	[-0.38, -0.05]	0.07	5.41*
Other Social											
DBRS: Imp. with adults (p)	685	0.59*	0.57*	0.38*	[0.29, 0.47]	0.28*	[0.19, 0.37]			0.38	212.11*
DBRS: Imp. with teacher (t)	412	0.55*	0.51*	0.37*	[0.25, 0.50]	0.20* ^{dh}	[0.08, 0.33]			0.32	94.55*
DBRS: Imp. with staff (t)	407	0.52*	0.52*	0.28*	[0.16, 0.41]	0.23* ^e	[0.09, 0.36]	0.10* ^d	[0.02, 0.19]	0.31	61.20*
YSR: Social Problems (s)	237	0.22*	0.22*	0.15	[-0.04, 0.34]	0.14	[-0.07, 0.34]			0.06	6.95*

Note. Only significant interactions reported, otherwise the model without the interaction is presented.

* $p < 0.01$, [^] $p = 0.01-0.05$ (2-tailed).

^aEffect no longer significant after controlling for IQ, ^bEffect became marginally significant after controlling for IQ, ^cEffect became significant after controlling for IQ, ^dEffect no longer significant after controlling for symptoms of ODD, ^eEffect became marginally significant after controlling for symptoms of ODD, ^fEffect became significant after controlling for symptoms of ODD, ^gEffect no longer significant after controlling for symptoms of depression, ^hEffect became marginally significant after controlling for symptoms of depression, ⁱEffect became significant after controlling for symptoms of depression.

Table 7

Time 3: Current symptoms of inattention and hyperactivity/impulsivity ('or-rule') and associated impairment in social functioning

	Zero-order Correlations			Multiple Regressions							
Measures (rater)	N	Inatt	Hyp/Imp	Inatt		Hyp/Imp		Interaction		Model	
				<i>B</i>	95% <i>CI</i>	<i>B</i>	95% <i>CI</i>	<i>B</i>	95% <i>CI</i>	<i>R</i> ²	<i>F</i>
Prosocial Behaviors/Skills											
BASC: Social skills (p)	64	-0.31 [^]	-0.31 [^]	-0.20	[-0.50, 0.10]	-0.19	[-0.49, 0.12]			0.08	4.13 [^]
BASC: Leadership (p)	64	-0.38*	-0.20	-0.40* ^h	[-0.70, -0.11]	0.05	[-0.25, 0.35]			0.11	5.02 [^]
Friendship											
SRS: Like (p)	65	-0.28 [^]	-0.38*	-0.07	[-0.37, 0.22]	-0.33 [^]	[-0.63, -0.04]			0.14	5.32*
SRS: Dislike (p)	64	0.38*	0.34*	0.27	[-0.03, 0.57]	0.17	[-0.13, 0.47]			0.13	5.88*
Number of friends (p)	61	-0.22	-0.18								
Aggression											
BASC: Aggression (p)	64	0.40*	0.41*	0.23	[-0.05, 0.52]	0.27	[-0.02, 0.56]			0.18	7.76*
SRQ: Relational agg. (p)	66	0.27 [^]	0.16	0.27	[-0.04, 0.58]	0.00	[-0.31, 0.31]			0.04	2.41
RPAQ: Proactive agg. (s)	66	0.43*	0.40*	0.30 ^{^g}	[0.01, 0.58]	0.22	[-0.07, 0.50]			0.19	8.44*
RPAQ: Reactive agg. (s)	66	0.39*	0.34*	0.29 ^{^adg}	[0.00, 0.58]	0.17	[-0.13, 0.46]			0.14	6.29*

Table 7

Time 3: Current symptoms of inattention and hyperactivity/impulsivity ('or-rule') and associated impairment in social functioning

Social Isolation

BASC: Withdrawn (p)	64	0.09	0.10							
CLDQ: Social Isolation (p)	65	0.25 [^]	0.25 [^]	0.16	[-0.15, 0.46]	0.16	[-0.15, 0.47]		0.05	2.64
SRS: Ignore (p)	64	0.15	0.21							
CSBQ: Withdrawn (p)	65	0.19	0.21							
Loneliness Scale (s)	66	0.07	0.11							
UCLA Loneliness (s)	66	0.21	0.27 [^]	0.08	[-0.23, 0.39]	0.22	[-0.08, 0.53]			2.61

Cognitive Empathy

CLDQ: Social cognition (p)	65	0.42*	0.45*	0.24	[-0.04, 0.52]	0.30 ^{^ad}	[0.02, 0.59]		0.21	9.49*
CSBQ: Difficulty understanding social (p)	66	0.39*	0.46*	0.06	[-0.22, 0.33]	0.37 ^{*h}	[0.10, 0.63]	0.27 ^{*b} [0.09, 0.46]	0.30	10.08*
CSBQ: Bx not optimal (p)	49	0.50*	0.44*	0.37 ^{^adg}	[0.07, 0.66]	0.24	[-0.08, 0.56]		0.26	9.24*
IRI: Perspective taking (s)	66	-0.34*	-0.30 [^]	-0.26	[-0.55, 0.04]	-0.14	[-0.44, 0.15]		0.10	4.73 [^]

Affective Empathy

APSD: Callous (p)	65	0.48*	0.47*	0.31 ^{^ad}	[0.03, 0.58]	0.28 ^{^adg}	[0.01, 0.56]		0.25	11.91*
APSD: Narcissism (p)	65	0.38*	0.41*	0.22	[-0.07, 0.51]	0.29 ^{^adg}	[0.00, 0.57]		0.17	7.72*
Empathy Quotient (p)	66	-0.44*	-0.43*	-0.29 ^{^ag}	[-0.57, -0.01]	-0.25	[-0.53, 0.03]		0.21	9.61*
IRI: Empathic concern (s)	66	-0.18	-0.01							
IRI: Personal distress (s)	65	0.22	0.14							

Table 7

Time 3: Current symptoms of inattention and hyperactivity/impulsivity ('or-rule') and associated impairment in social functioning

Note. Only significant interactions reported, otherwise the model without the interaction is presented. 'Or-rule' computed from parent- and self- ratings of ADHD.

* $p < 0.01$, $^{\wedge}p = 0.01 - 0.05$ (2-tailed).

^aEffect no longer significant after controlling for IQ, ^bEffect became marginally significant after controlling for IQ, ^cEffect became significant after controlling for IQ, ^dEffect no longer significant after controlling for symptoms of CD, ^eEffect marginally significant after controlling for symptoms of CD, ^fEffect significant after controlling for symptoms of CD, ^gEffect no longer significant after controlling for internalizing symptoms, ^hEffect marginally significant after controlling for internalizing symptoms, ⁱEffect significant after controlling for internalizing symptoms.

A similar pattern of results was apparent at Time 3 for parent-rated social skills, though the correlation was smaller. Both symptom dimensions were inversely correlated with leadership qualities as rated by parents at all three time points, and this association was generally in the moderate range for inattentive symptoms.

On further examination, multiple regression analyses of the Time 1 data showed that while both inattention and hyperactivity/impulsivity independently predicted deficits in social skills and decreased prosocial behavior, this effect was significantly larger for inattention than for hyperactivity (for all p , F , R^2 , β , and CI values cited in this section, see Tables 5, 6, & 7). However, with respect to leadership qualities, inattention predicted a decrease in parent ratings of leadership qualities, while hyperactivity/impulsivity predicted an increase. At Time 2, the overall pattern of results was similar to the results at Time 1 on these measures. However, at Time 2 hyperactivity/impulsivity was not a significant predictor for prosocial behavior and leadership qualities and only marginally significant for social skills. Time 3 also demonstrated a similar predictive pattern, but the only significant result was inattentive symptoms predicting decreased ratings on leadership skills. At Time 1, there was a very small but significant interaction between inattention and hyperactivity/impulsivity predicting prosocial behavior, an equally small but marginally significant interaction between inattention and hyperactivity/impulsivity predicting social skills, and there was not a significant interaction predicting leadership qualities. These interactions were not significant predictors at Time 2 or Time 3 for any of the measures.

Subtype Comparisons. At Time 1 and 2, children in the ADHD-C and ADHD-I groups were significantly more impaired than comparison children on measures of social skills, prosocial behavior, and leadership skills; this was a large effect (see Table 8 & 10 for raw means and standard deviations and Table 9 & 11 for p values and Cohen's d).

Table 8

Time 1: DSM-IV ADHD subtype means and standard deviations on measures of social functioning

Group means								
	Control		ADHD-I		ADHD-H		ADHD-C	
Measure (rater)	<i>N</i>	<i>Mean (SD)</i>	<i>N</i>	<i>Mean (SD)</i>	<i>N</i>	<i>Mean (SD)</i>	<i>N</i>	<i>Mean (SD)</i>
Prosocial Behaviors/Skills								
BASC: Social Skills (parent)	2401	51.85 (9.38)	397	44.44 (10.07)	107	47.29 (10.36)	323	41.82 (10.80)
TASB: Prosocial (teacher)	2717	4.41 (0.77)	362	3.73 (0.91)	108	3.59 (0.78)	334	3.25 (0.84)
BASC: Leadership (parent)	1507	51.89 (10.31)	274	42.86 (9.25)	67	51.45 (10.56)	249	43.81 (9.40)
Friendship								
DBRS: Impairment with peers (p)	7260	0.37 (0.67)	751	1.00 (0.89)	270	0.97 (0.84)	581	1.49 (0.97)
DBRS: Impairment with peers (t)	6137	0.32 (0.63)	660	1.20 (0.97)	237	1.11 (0.93)	535	1.79 (0.98)
SRS: Like (p)	5369	4.50 (0.88)	587	3.90 (1.17)	167	4.08 (1.10)	475	3.56 (1.30)
SRS: Like (t)	5109	4.53 (0.84)	593	3.66 (1.31)	157	3.83 (1.13)	495	3.21 (1.32)
SRS: Dislike (p)	5343	1.19 (0.58)	584	1.52 (0.88)	167	1.41 (0.73)	474	1.88 (1.10)
SRS: Dislike (t)	5106	1.12 (0.45)	593	1.52 (0.92)	155	1.53 (0.81)	494	1.98 (1.24)
Number of friends (p)	4417	2.70 (0.93)	492	2.28 (1.05)	150	2.46 (1.03)	430	2.05 (1.08)

Table 8

Time 1: DSM-IV ADHD subtype means and standard deviations on measures of social functioning

Aggression								
BASC: Aggression (p)	2404	46.13 (9.05)	397	51.14 (10.57)	107	55.71 (12.49)	323	59.11 (13.00)
SRQ: Relational aggression (p)	3990	1.40 (0.72)	512	1.66 (0.90)	145	1.96 (0.97)	426	2.13 (1.08)
TASB: Aggression (t)	2717	1.31 (0.63)	360	1.61 (0.79)	108	2.02 (0.91)	334	2.42 (1.12)
YSR: Aggression (s)	406	5.95 (3.91)	59	6.80 (4.56)	9	11.07 (6.82)	16	10.66 (6.77)
Social Isolation								
BASC: Withdrawn (p)	2405	48.55 (10.08)	397	52.73 (11.67)	107	48.53 (10.29)	323	52.69 (12.25)
CLDQ: Social Isolation (p)	4853	1.53 (0.70)	599	2.12 (0.96)	163	1.73 (0.71)	461	2.28 (1.03)
SRS: Ignore (p)	5340	1.33 (0.72)	578	1.76 (1.03)	166	1.45 (0.84)	473	1.89 (1.08)
SRS: Ignore (t)	5111	1.39 (0.77)	594	2.08 (1.17)	157	1.65 (0.84)	495	2.13 (1.11)
TASB: Shy/withdrawn (t)	2717	1.59 (0.75)	362	2.16 (0.97)	108	1.56 (0.60)	334	2.00 (0.90)
YSR: Withdrawn (s)	333	2.71 (2.09)	53	3.45 (2.45)	7	2.43 (2.57)	13	3.77 (2.20)
Loneliness Scale (s)	345	5.15 (4.48)	102	8.24 (6.44)	34	6.41 (5.63)	142	9.39 (7.57)
Cognitive Empathy								
CLDQ: Social Cognition (p)	4853	1.42 (0.59)	599	2.14 (0.90)	163	2.06 (0.85)	461	2.69 (1.01)

Table 8

Time 1: DSM-IV ADHD subtype means and standard deviations on measures of social functioning

Affective Empathy									
APSD: Callous (p)	1962	2.48 (2.07)	289	3.58 (2.01)	91	3.09 (1.88)	259	4.05 (2.07)	
APSD: Narcissism (p)	1962	2.32 (2.26)	289	3.32 (2.73)	91	4.46 (3.22)	259	4.65 (3.29)	
Other Social									
DBRS: Impairment with other adults (p)	7262	0.35 (0.64)	751	0.95 (0.79)	270	0.95 (0.76)	581	1.43 (0.92)	
DBRS: Impairment with teachers (t)	6136	0.30 (0.60)	660	1.24 (0.90)	237	1.11 (0.94)	534	1.76 (0.93)	
DBRS: Impairment with staff (t)	6132	0.23 (0.53)	657	0.99 (0.85)	237	0.97 (0.87)	533	1.60 (0.98)	
YSR: Social Problems (s)	406	2.21 (2.07)	59	3.25 (2.35)	9	2.22 (2.77)	16	3.81 (3.21)	

Note. Raw score means.

Table 9

Time 1: Effect size differences between DSM-IV ADHD subtypes on measures of social functioning

Measure (rater)	Estimated effect size of the mean difference between groups					
	ADHD-C	ADHD-I	ADHD-H	ADHD-C	ADHD-C	ADHD-I
	vs. Control	vs. Control	vs. Control	vs. ADHD-I	vs. ADHD-H	vs. ADHD-H
	<i>Cohen's d</i>	<i>Cohen's d</i>	<i>Cohen's d</i>	<i>Cohen's d</i>	<i>Cohen's d</i>	<i>Cohen's d</i>
Prosocial Behaviors/Skills						
BASC: Social Skills (p)	-0.94 ^{*d}	-0.74 [*]	-0.43 ^{*g}	-0.25 ^{*edg}	-0.53 [*]	-0.30 ^{*bh}
TASB: Prosocial (t)	-1.33 [*]	-0.74 [*]	-0.98 [*]	-0.54 [*]	-0.40 ^{*adg}	0.17
BASC: Leadership (p)	-0.83 [*]	-0.92 [*]	-0.05	0.09 ^e	-0.76 [*]	-0.85 [*]
Friendship						
DBRS: Imp. with peers (p)	1.45 [*]	0.88 [*]	0.87 [*]	0.51 [*]	0.55 [*]	0.03
DBRS: Imp. with peers (t)	1.89 [*]	1.14 [*]	1.05 [*]	0.58 [*]	0.69 [*]	0.09
SRS: Like (p)	-0.79 [*]	-0.51 [*]	-0.41 ^{*bdg}	-0.30 [*]	-0.40 [*]	-0.10
SRS: Like (t)	-1.12 [*]	-0.72 [*]	-0.66 ^{*d}	-0.35 ^{*d}	-0.50 [*]	-0.13
SRS: Dislike (p)	0.84 [*]	0.46 [*]	0.38 ^{*adg}	0.38 [*]	0.50 [*]	0.10 ^b
SRS: Dislike (t)	0.99 [*]	0.58 [*]	0.67 ^{*e}	0.43 [*]	0.40 [*]	-0.05
Number of friends (p)	-0.65 [*]	-0.42 ^{*h}	-0.26 ^{*adg}	-0.23 ^{*ag}	-0.38 ^{*bg}	-0.15 ^e

Table 9

Time 1: Effect size differences between DSM-IV ADHD subtypes on measures of social functioning

Aggression						
BASC: Aggression (p)	1.19*	0.51*	0.88*	0.67*	0.27* ^{bg}	-0.40* ^d
SRQ: Relational agg. (p)	0.84* ^d	0.34* ^d	0.69* ^d	0.49* ^d	0.16* ^{adg}	-0.34* ^{cd}
TASB: Aggression (t)	1.30*	0.46* ^d	0.95*	0.82*	0.37* ^d	-0.47* ^h
YSR: Aggression (s)	0.83* ^{dg}	0.49* ^d	0.57	0.82	0.37	-0.47
Social Isolation						
BASC: Withdrawn (p)	0.38* ^{dg}	0.39* ^g	0.01* ^{di}	0.00* ^{dh}	0.36* ^{be}	0.37* ^b
CLDQ: Social Isolation (p)	0.90*	0.71*	0.34* ^{dg}	0.17* ^{bdg}	0.59*	0.41*
SRS: Ignore (p)	0.65*	0.48*	0.19* ^{ad}	0.16* ^{ad}	0.46*	0.29*
SRS: Ignore (t)	0.85*	0.70*	0.40* ^{bdh}	0.12* ^{adg}	0.46*	0.33* ^h
TASB: Shy/withdrawn (t)	0.52* ^{eg}	0.65*	0.01	-0.14* ^g	0.54* ^g	0.68*
YSR: Withdrawn (s)	0.57	0.27	-0.19	0.27	0.73	0.43
Loneliness Scale (s)	0.44* ^e	0.51*	0.15	-0.03	0.30	0.36
Cognitive Empathy						
CLDQ: Social Cognition (p)	1.44*	0.51*	1.42*	0.90*	0.14* ^c	-0.82* ^a
Affective Empathy						
APSD: Callous (p)	0.72* ^e	0.56*	0.25* ^{ad}	0.17	0.51* ^e	0.34* ^{bg}
APSD: Narcissism (p)	0.86* ^{dg}	0.42* ^{dg}	0.74* ^{dg}	0.44* ^d	0.08	-0.34* ^{dg}

Table 9

Time 1: Effect size differences between DSM-IV ADHD subtypes on measures of social functioning

Other Social						
DBRS: Imp. with adults (p)	1.46*	0.93*	0.95*	0.50*	0.51*	0.00
DBRS: Imp. with teacher (t)	2.00*	1.30*	1.08*	0.52*	0.69*	0.17* ^{eg}
DBRS: Imp. with staff (t)	1.87*	1.16*	1.08*	0.60*	0.65*	0.05
YSR: Social Problems (s)	0.62 ^a	0.60*	-0.02	0.06	0.51	0.48

Note. Effect sizes calculated from age-corrected, log transformed, and standardized means.

* $p < 0.01$, ^a $p = 0.01-0.05$ (2-tailed).

^aEffect no longer significant after controlling for IQ, ^bEffect became marginally significant after controlling for IQ, ^cEffect became significant after controlling for IQ, ^dEffect no longer significant after controlling for symptoms of ODD, ^eEffect marginally significant after controlling for symptoms of ODD, ^fEffect significant after controlling for symptoms of ODD, ^gEffect no longer significant after controlling for symptoms of anxiety and depression, ^hEffect marginally significant after controlling for symptoms of anxiety and depression, ⁱEffect significant after controlling for symptoms of anxiety and depression.

Table 10

Time 2: DSM-IV ADHD subtype means and standard deviations on measures of social functioning

Group means								
	Control		ADHD-I		ADHD-H		ADHD-C	
Measure (rater)	<i>N</i>	<i>Mean (SD)</i>	<i>N</i>	<i>Mean (SD)</i>	<i>N</i>	<i>Mean (SD)</i>	<i>N</i>	<i>Mean (SD)</i>
Prosocial Behaviors/Skills								
BASC: Social skills (p)	543	53.10 (9.88)	77	44.66 (10.09)	14	50.64 (12.97)	51	39.02 (10.30)
TASB: Prosocial (t)	164	4.34 (0.78)	44	3.36 (1.04)	8	3.46 (0.78)	32	3.58 (0.92)
BASC: Leadership (p)	293	52.27 (10.10)	55	43.11 (9.14)	10	52.50 (10.34)	44	42.50 (9.28)
Friendship								
DBRS: Impairment with peers (p)	543	0.31 (0.60)	77	1.01 (0.87)	14	0.93 (1.00)	51	1.69 (0.99)
DBRS: Impairment with peers (t)	311	0.27 (0.62)	53	1.21 (0.97)	12	1.58 (0.79)	35	1.46 (1.04)
SRS: Like (p)	296	4.45 (0.86)	56	3.68 (1.16)	10	4.10 (1.10)	44	3.61 (1.47)
SRS: Like (t)	317	4.59 (0.80)	55	3.38 (1.41)	12	3.50 (0.80)	37	3.49 (1.30)
SRS: Dislike (p)	296	1.21 (0.54)	56	1.50 (0.74)	10	1.20 (0.42)	44	1.73 (1.19)
SRS: Dislike (t)	317	1.13 (0.46)	55	1.73 (1.16)	12	2.08 (1.08)	37	1.73 (1.26)
Number of friends (p)	543	2.34 (0.74)	77	2.08 (0.82)	14	2.21 (0.70)	51	2.12 (0.89)

Table 10

Time 2: DSM-IV ADHD subtype means and standard deviations on measures of social functioning

Aggression								
BASC: Aggression (p)	543	46.57 (8.15)	77	51.57 (10.15)	14	52.71 (9.82)	51	63.57 (12.15)
SRQ: Relational aggression (p)	218	1.35 (0.62)	51	1.69 (0.92)	9	2.19 (0.87)	41	1.95 (0.98)
TASB: Aggression (t)	164	1.17 (0.40)	44	1.82 (0.86)	8	2.33 (0.94)	33	2.24 (0.95)
YSR: Aggression (s)	208	6.69 (4.96)	18	7.89 (7.28)	4	12.00 (4.16)	7	14.14 (7.82)
Social Isolation								
BASC: Withdrawn (p)	543	47.31 (10.49)	77	52.52 (11.22)	14	46.00 (10.61)	51	53.33 (10.40)
CLDQ: Social Isolation (p)	296	1.56 (0.74)	56	2.19 (0.93)	10	1.63 (0.66)	44	2.36 (0.85)
SRS: Ignore (p)	296	1.41 (0.70)	56	2.07 (1.02)	10	1.40 (0.70)	44	1.89 (1.08)
SRS: Ignore (t)	317	1.37 (0.81)	55	2.16 (1.24)	12	1.75 (0.62)	37	1.84 (0.93)
TASB: Shy/withdrawn (t)	164	1.78 (0.74)	44	2.22 (0.87)	8	1.79 (0.43)	32	1.96 (0.96)
YSR: Withdrawn (s)	208	2.23 (2.18)	18	2.72 (2.54)	4	1.75 (1.26)	7	4.14 (1.77)
Loneliness Scale (s)	117	4.85 (4.47)	27	8.66 (6.54)	6	8.83 (6.94)	29	7.42 (6.20)
Cognitive Empathy								
CLDQ: Social Cognition (p)	296	1.46 (0.63)	56	2.28 (0.97)	10	2.08 (0.83)	44	2.93 (0.91)
CLDQ: Social Cognition (t)	163	1.30 (0.46)	43	2.30 (1.12)	8	2.51 (0.85)	31	2.45 (0.97)

Table 10

Time 2: DSM-IV ADHD subtype means and standard deviations on measures of social functioning

Affective Empathy									
APSD: Callous (p)	201	2.42 (2.09)	31	3.55 (2.11)	7	4.14 (2.54)	34	4.18 (1.87)	
APSD: Narcissism (p)	201	2.22 (2.44)	31	3.84 (2.79)	7	4.57 (2.94)	34	5.76 (3.02)	
Family Relationships									
CBCL: Gets along with family (p)	247	1.42 (0.53)	21	1.14 (0.66)	4	2.00 (0.00)	7	0.57 (0.54)	
YSR: Gets along with family (s)	206	1.41 (0.56)	18	1.17 (0.62)	4	1.25 (0.50)	7	1.29 (0.49)	
CBCL: Gets along with siblings (p)	247	1.24 (0.55)	21	0.90 (0.44)	4	1.00 (0.82)	7	0.86 (0.69)	
YSR: Gets along with siblings (s)	206	1.26 (0.58)	17	1.00 (0.61)	4	0.75 (0.96)	7	0.86 (0.69)	
Other Social									
DBRS: Impairment with other adults (p)	543	0.41 (0.63)	77	1.17 (0.82)	14	1.00 (0.88)	51	1.69 (0.88)	
DBRS: Impairment with teachers (t)	312	0.29 (0.63)	53	1.13 (1.02)	12	1.67 (0.65)	35	1.49 (1.15)	
DBRS: Impairment with staff (t)	307	0.19 (0.50)	53	0.91 (0.88)	12	1.50 (0.67)	35	1.20 (1.02)	
YSR: Social Problems (s)	208	2.01 (2.07)	18	2.28 (2.65)	4	2.50 (1.73)	7	4.86 (3.08)	

Note. Raw score means.

Table 11

Time 2: Effect size differences between DSM-IV ADHD subtypes on measures of social functioning

Estimated effect size of the mean difference between groups						
Measure (rater)	ADHD-C	ADHD-I	ADHD-H	ADHD-C	ADHD-C	ADHD-I
	vs. Control	vs. Control	vs. Control	vs. ADHD-I	vs. ADHD-H	vs. ADHD-H
	<i>Cohen's d</i>	<i>Cohen's d</i>	<i>Cohen's d</i>	<i>Cohen's d</i>	<i>Cohen's d</i>	<i>Cohen's d</i>
Prosocial Behaviors/Skills						
BASC: Social skills (p)	-1.33*	-0.82*	-0.13 ^{*adg}	-0.50 ^{*adg}	-1.02 ^{*e}	-0.58 ^e
TASB: Prosocial (t)	-0.96 ^{*d}	-1.07*	-1.51 ^{^d}	0.24	0.21	-0.14
BASC: Leadership (p)	-1.01 ^{*e}	-0.95*	0.02	-0.07	-1.02 ^{^d}	-0.96 [^]
Friendship						
DBRS: Imp. with peers (p)	1.77*	0.99*	0.68 ^{^d}	0.66 ^{*dh}	0.83 ^{*d}	0.21
DBRS: Imp. with peers (t)	1.39*	1.19*	1.94*	0.18 ^g	-0.22	-0.43
SRS: Like (p)	-0.71 ^{*dh}	-0.71*	-0.34	-0.12	-0.44	-0.37
SRS: Like (t)	-0.92 ^{*d}	-0.97*	-1.14 ^{^d}	0.10 ^e	-0.13	-0.24
SRS: Dislike (p)	0.56 ^{*d^g}	0.46 ^{*d^g}	0.01 ^g	0.17 ^g	0.57 ^g	0.47 ^g
SRS: Dislike (t)	0.63 ^{*d}	0.73*	1.25*	-0.03	-0.41	-0.40
Number of friends (p)	-0.27	-0.30 ^{^d}	-0.10	0.02	-0.20	-0.23

Table 11

Time 2: Effect size differences between DSM-IV ADHD subtypes on measures of social functioning

Aggression						
BASC: Aggression (p)	1.73*	0.55* ^{d^g}	0.70 ^{ch}	1.12* ^d	1.01* ^{adg}	-0.14
SRQ: Relational aggression (p)	0.79* ^d	0.44 ^{^d}	1.18* ^d	0.30	-0.31	-0.62
TASB: Aggression (t)	1.61*	1.00*	1.68*	0.49 ^{^d}	-0.10	-0.58
YSR: Aggression (s)	1.04	0.07	1.25	0.89	0.04	-1.04
Social Isolation						
BASC: Withdrawn (p)	0.61* ^{dg}	0.51* ^g	-0.13	0.09	0.73	0.62
CLDQ: Social Isolation (p)	1.08* ^{eh}	0.71*	0.16	0.23	0.95	0.65
SRS: Ignore (p)	0.55* ^{dh}	0.76*	0.07	-0.18	0.48	0.68
SRS: Ignore (t)	0.60* ^{bdg}	0.82* ^h	0.66	-0.26 ^e	0.03	0.32
TASB: Shy/withdrawn (t)	0.22	0.55* ^{bd}	0.03	-0.28	0.23	0.62
YSR: Withdrawn (s)	1.19	0.16	-0.07	0.88	1.35	0.23
Loneliness Scale (s)	0.43	0.71* ^{bg}	0.63	-0.26	-0.18	0.09

Table 11

Time 2: Effect size differences between DSM-IV ADHD subtypes on measures of social functioning

Cognitive Empathy						
CLDQ: Social cognition (p)	1.80*	1.05*	0.90 ^{^d}	0.53* ^d	0.77 ^{^dg}	0.19
CLDQ: Social cognition (t)	1.62*	1.20*	1.94*	0.20	-0.11	-0.31
Affective Empathy						
APSD: Callous (p)	0.89*d ^g	0.54 ^{^dg}	0.74	0.32	0.02	-0.25
APSD: Narcissism (p)	1.50* ^d	0.68* ^{bdg}	0.94 ^{bd}	0.74	0.45	-0.26
Family Relationships						
CBCL: Get along/family (p)	-1.59*	-0.47	1.55	-0.95	-3.77*	-1.85 [^]
YSR: Get along/family (s)	-0.23	-0.41	-0.30	0.22	0.08	-0.15
CBCL: Get along/sibling (p)	-0.54	-0.63	-0.31	-0.03	-0.14	-0.14
YSR: Get along/sibling (s)	-0.49	-0.41	-0.57	-0.09	0.19	0.26

Table 11

Time 2: Effect size differences between DSM-IV ADHD subtypes on measures of social functioning

Note. Effect sizes calculated from age-corrected, log transformed, and standardized means.

* $p < 0.01$, ^a $p = 0.01-0.05$ (2-tailed).

^aEffect no longer significant after controlling for IQ, ^bEffect marginally significant after controlling for IQ, ^cEffect significant after controlling for IQ, ^dEffect no longer significant after controlling for symptoms of ODD, ^eEffect marginally significant after controlling for symptoms of ODD, ^fEffect significant after controlling for symptoms of ODD, ^gEffect no longer significant after controlling for symptoms of anxiety and depression, ^hEffect marginally significant after controlling for symptoms of anxiety and depression, ⁱEffect significant after controlling for symptoms of anxiety and depression.

The group with ADHD-H also exhibited fewer prosocial behaviors than the control group at both time points. In contrast, the group with ADHD-H was significantly more impaired than the comparison group on the measure of social skills at Time 1, but this effect size was more modest than the effect for prosocial behaviors, and was not significant at Time 2. Further, there was no significant difference between ADHD-H and comparison children with respect to leadership qualities at either time point.

Between subtypes, at Time 1 and 2, the ADHD-C group was significantly more impaired than the ADHD-I group on social skills, but it was only a small effect at Time1 and a medium effect at Time 2. At Time 1, ADHD-C was significantly more impaired than ADHD-H group on social skills; this was a medium effect. There was also a significant difference and medium effect such that ADHD-I was more impaired on social skills than ADHD-H. At Time 1, ADHD-C was significantly more impaired than ADHD-I and ADHD-H on prosocial behaviors and both differences were medium effects. There was not a significant difference between ADHD-I and ADHD-H at Time1 for prosocial behavior nor were there any significant subtype comparisons on the measure of prosocial behavior at Time 2. With respect to leadership qualities, ADHD-C and ADHD-I were both significantly more impaired than the ADHD-H group with a large effect at Time 1, but there was not a significant difference between the ADHD-C and ADHD-I groups at Time 1 or 2.

Intellectual Functioning. Intellectual functioning could potentially account for much of an individual's social abilities, thus the previous regression models were run covarying the IQ estimate available for a subset of the participants. After controlling for IQ, all effects remained the same except that hyperactive/impulsive symptoms were no longer a significant predictor of parent report of social skills at Time 2 (see footnotes of Tables 5, 6, & 7). There was no change in the pattern of results for differential prosocial behaviors by ADHD subtype at Time 1 or Time 2.

Comorbid Psychopathology. As discussed previously, ADHD is a diagnosis that is highly comorbid with a wide range of other psychopathology, including disorders such as depression and conduct disorder that have a significant impact on social functioning. Therefore, to test whether any observed social impairments were associated specifically with ADHD and not a consequence of these comorbid symptoms, multiple regression analyses were conducted in which the best available measures of ODD symptoms and anxiety and depression symptoms were added as additional independent predictors at each time point. After controlling for ODD symptoms, hyperactivity/impulsivity was no longer significantly associated with a decrease in social skills or prosocial behavior (see footnotes of 5, 6, & 7). In contrast, the relationship previously found between hyperactivity/impulsivity and leadership, and all effects of inattention on social skills, prosocial behavior, and leadership remained unchanged after controlling for ODD. With regard to ADHD subtypes, the results remained unchanged with the exception that a few differences between the ADHD subtypes are no longer significant.

When controlling for parent ratings of depression at Time 1 and 2, the only difference in results was that hyperactivity/impulsivity was no longer a significant predictor of parent-rated social skills. This is likely due to the fact that parent ratings of depression were only available in a subset of the sample and the effect for hyperactivity/impulsivity was small enough that we lost the power to detect this effect. Overall, there were no changes to the results for social skills by subtype at either Time 1 or 2.

When controlling for parent ratings of anxiety at Time1, there were no changes to the effects. When controlling for internalizing symptoms at Time 3, inattention symptoms became a marginally significant predictor of leadership, though this also was likely due to the small sample and losing power to detect the effect over and above any effects anxiety may have. There were few clear patterns of change when controlling for depression, the effects predominantly remain the same but the significance adjusts slightly. One clear pattern is that ADHD-H does not predict being liked or disliked by peers and fewer friends over and above depression.

Sex. After splitting the sample by sex and running multiple regressions, there were no differences in the pattern of results at any time point for males and females with one exception. For males at Time 1 and 2, hyperactivity/impulsivity did not predict decreased social skills.

Friendship

On parent- and teacher- rated measures of friendship at Time 1 and 2 and parent-rated measures of friendship at Time 3, there were small to moderate associations such that children with higher levels of inattentive and hyperactive/impulsive symptoms were rated as being more impaired in their interactions with peers, less well-liked by peers, and more actively disliked by peers (for all Pearson r values cited in this section, see Tables 5, 6, & 7). Children with increased levels of inattentive and hyperactive/impulsive symptoms were rated as having fewer friends by their parents at both Time 1 and Time 2, and the pattern was similar but not significant at Time 3. At Time 2, self-reported number of friends did not have a significant correlation with severity of inattentive and hyperactive/impulsive symptoms.

Further examination via multiple regressions at Time 1 confirmed this previous pattern of results, showing that both inattention and hyperactivity/impulsivity were independently associated with overall impairment with peers, being less often liked and more often disliked by peers, and having fewer friends (for all p , F , R^2 , β , and CI values cited in this section, see Tables 5, 6, & 7). The effects of inattentive symptoms and hyperactive/impulsive symptoms were similar for most measures at Time 1, except that inattention was more strongly associated with not being liked by peers. Time 2 showed similar patterns of results, except hyperactivity/impulsivity was not a significant predictor of teacher ratings of being liked by peers or parent ratings of number of friends, and there were no significant differences between the effects of inattention and hyperactivity/impulsivity for any of the measures.

At Time 3, the overall models with inattention and hyperactivity/impulsivity predicting children being liked and disliked by peers were significant, indicating that increased levels of ADHD symptoms predicted impairment. However, the regression coefficients for each symptom

dimension were not significant. Hyperactivity/impulsivity approached significance for predicting being less liked by peers, which is contrary to effects at earlier time points when inattention was the stronger predictor of this measure. Perhaps this suggests a change in which symptoms are more impairing later in development. Parent ratings of number of friends were not significant at Time 3, thus a regression was not run for this measure.

For most measures of friendship at Time 1, the interaction of ADHD symptoms was significant such that, at various levels of severity of one symptom dimension, having an increased level of severity of the other symptom dimension would result in increased impairment on the measures of friendship. The exceptions to this were significant negative interactions for teacher ratings of being disliked by peers and parent rated number of friends. At Time 2, the only interaction that was significant was a marginally significant negative interaction for teacher ratings of being liked by peers. No interactions were significant at Time 3.

Subtype Comparisons. When comparing diagnostic subtypes at Time 1, all ADHD diagnostic groups were significantly more impaired on all measures of friendship than the comparison group (for all models discussed in this section see Tables 8 & 10 for raw means and standard deviations and Tables 9 & 11 for Cohen's *d*). Subtype comparisons indicated that ADHD-C was significantly more impaired than either ADHD-I or ADHD-H. However, ADHD-I and ADHD-H were not significantly different with respect to friendship. At Time 2, the pattern of results remained the same, except that there was not a significant difference between ADHD-C and comparison groups and only a marginally significant difference between ADHD-I and comparison children for parent rated number of friends. Further, there were no significant group differences between ADHD-C and ADHD-I on any of the friendship measures except for the parent rating of impairment with peers. For the two additional measures at Time 2, a parent rating of how their child gets along with peers and a self-rating of number of friends, there were no significant differences between either ADHD-C or ADHD-I and comparison children. All

effects were considered to be moderate to large effects except for parent ratings of friendship, which was a small effect for ADHD-H and moderate effects for ADHD-C and ADHD-I.

Intellectual Functioning. When estimated IQ was controlled for in the previous regression models, all effects remained the same except that hyperactive/impulsive symptoms were no longer a significant predictor of parent report of the child's number of friends at Time 1, inattention was no longer a significant predictor and hyperactivity/impulsivity became a marginal predictor of teacher ratings of being disliked by peers at Time 2, and there was no change in the results at Time 3 (see footnotes of Tables 5, 6, & 7). There was no change in the pattern of results for ADHD subtypes by friendship at Time 1 or Time 2.

Comorbid Psychopathology. When multiple regressions were run controlling for mean severity of ODD symptoms, hyperactivity/impulsivity was no longer a significant predictor of parent ratings of being disliked by peers, teacher ratings of being liked and disliked by peers, and parent ratings of number of friends at Time 1 (see footnotes of Tables 5, 6, & 7). It was no longer a significant predictor of dislike by peers at Time 2. There were no differences for other measures of impairment in friendship at either Time 1 or 2, and there were no changes to results at Time 3. When controlling for ODD symptoms, ADHD-H no longer has significantly different friendship quality than the comparison group at Time 1, and a similar trend was found at Time 2.

The only significant effects of controlling for internalizing symptoms occurred at Time 2 where it weakened the relationships between inattention and hyperactivity/impulsivity with being liked or disliked by peers. The difference between ADHD-I and ADHD-C with respect to predicting social isolation was less stable in the presence of depression symptoms. After controlling for depression, ADHD-H was no longer significantly different from control on several measures of friendship at Time 1. At Time 2, there were few changes except that ratings of being disliked peers were no longer different among groups after controlling for depression.

Sex. After splitting the sample by sex and running multiple regressions, there was generally no difference in friendship effects for males at any time point. For females at Time 1 and 3, there were no differences in the results for friendship. At Time 2, each symptom dimension lost significance for at least one outcome measure, but this was likely due to losing power from splitting the sample, because the effects were of a similar magnitude and in the same direction as the original analysis.

Aggression

At Time 1 and 2, both hyperactive/impulsive and inattentive symptoms were significantly and positively correlated with parent-, teacher-, and self-ratings of aggression (for all Pearson r values cited in this section, see Tables 5, 6, & 7). However, hyperactive/impulsive symptoms generally had a higher correlation with measures of aggression than inattentive symptoms. At Time 3, parent- and self-report ratings of aggression had a significant positive correlation with inattentive and hyperactive/impulsive symptoms in the small to moderate range with the exception of a measure of relational aggression where only inattentive symptoms had a marginally significant positive correlation. Further examination via multiple regressions demonstrated that hyperactivity/impulsivity was a significant predictor of all measures of aggression at Time 1 and 2 (for all p , F , R^2 , β , and CI values cited in this section, see Tables 5, 6, & 7). Inattention was also a significant predictor of aggression at Time 1 and 2, though it was a weaker effect than for hyperactivity/impulsivity and less frequently significant. The only significant interaction between inattention and hyperactivity/impulsivity symptoms at Time 1 and 2 was for teacher rated aggression. It was a positive interaction indicating that while inattention did not strongly predict aggression at either time point, for a particular severity level of hyperactivity/impulsivity, increased severity of inattention predicted increased aggression.

Only parent-rated overall aggression and parent-rated relational aggression were administered at all three time points, and both symptom dimensions had significant positive correlations with these measures. While the regression effects for these measures were

generally in the same direction at Time 3 as they were at Time 1 and 2, neither inattention nor hyperactivity/impulsivity was a significant predictor of these aggression measures. A new measure was administered at Time 3- a self-report of proactive and reactive aggression- and the effects indicated that both inattention and hyperactivity were associated with increased aggression on both scales. However, only inattention was a marginally significant predictor of both types of aggression. There were no significant interactions for any of the models at Time 3.

Subtype Comparisons. At Time 1, all three subtypes were rated as significantly more aggressive than comparison group on all measures with the exception that ADHD-H was not significantly different than the comparison group for self-rated aggression (for all models discussed in this section see Tables 8 & 10 for raw means and standard deviations and Tables 9 & 11 for Cohen's *d*). ADHD-C was rated as being significantly more aggressive than each ADHD-I and ADHD-H on all measures except self-rated aggression, on which there were no significant subtype differences. ADHD-H was rated as significantly more aggressive than ADHD-I for parent-rated aggression and teacher-rated aggression, and marginally significant for increased relational aggression. Data at Time 2 demonstrated the same pattern of differential aggression between ADHD subtypes and controls. However, in contrast to Time 1, ADHD-C was only rated as significantly more aggressive than ADHD-I for parent- and teacher-rated aggression (only marginal for teacher rating).

Intellectual Functioning. At Time 1, when estimated IQ was added into the model as a covariate, inattentive symptoms were no longer a significant predictor of relational aggression and teacher ratings of aggressive behavior in the classroom (TASB). Otherwise, all other effects remained the same. The marginally significant effect of inattentive symptoms predicting relational aggression went away at Time 3 after controlling for IQ. There was no change in the pattern of results for ADHD subtypes by prosocial behaviors at Time 1 or Time 2

Comorbid Psychopathology. When multiple regressions were run controlling for mean severity of ODD symptoms, inattention no longer significantly predicted any measures of aggression except parent-rated overall aggression at Time 1, and at Time 2 it no longer predicted any measures of aggression at all. Hyperactivity/impulsivity no longer significantly predicted self-reported aggression at Time 1 and no longer significantly predicted parent-rated relational aggression at Time 2. The interaction of hyperactivity/impulsivity and inattention was no longer significant for teacher-rated aggression at Time 2 after controlling for ODD symptoms. After controlling for ODD symptoms, many of the differences in aggression between the ADHD subtypes with each other and with the comparison group are no longer significant. Notably, for all measures of aggression except parent-rated overall aggression, ADHD-I is no longer significantly different from comparison control.

When controlling for parent-ratings of depression and anxiety at Time 1, inattention was no longer a significant predictor for any measures of aggression. There were no changes to effects at Time 2. The marginally significant results at Time 3 lost significance, which may just be an indicator of low power since this was the effect of controlling for internalizing symptoms on any significant predictor at Time 3. The only difference in the pattern of results, after controlling depression, was that ADHD-H and ADHD-C are no longer significantly different on measures of overall aggression and relational aggression.

Sex. After splitting the sample by sex and running multiple regressions, generally there were no differences in the results at Time 1 or 2. However, for males at Time 1, inattention no longer predicted teacher-rated aggression and relational aggression. For females at Time 1, inattention no longer predicted self-rated aggression, and the regression coefficient was substantially smaller. However, on other measures of aggression at Time 1, inattention was likely no longer significant due to reduced power from splitting the sample as evidenced by the regression coefficients being of similar magnitude and going the same direction as in the original analyses. At Time 3, there was a differential effect such that inattention no longer

predicted proactive aggression in males, but it was a significant predictor for proactive aggression in females.

Social Isolation

A pattern opposite to that observed on the measures of aggression was evident for parent-, teacher-, and self- ratings of social isolation. In comparison to hyperactivity-impulsivity symptoms, inattentive symptoms generally had a higher correlation with increased shy and withdrawn behavior, feelings of loneliness, and being ignored by peers at both Time 1 and Time 2 (for all Pearson r values cited in this section, see Tables 5, 6, & 7). Multiple regressions demonstrated that inattention significantly predicted all measures of social isolation and withdrawal at Time 1 and Time 2 with the exception of self-rated withdrawal symptoms at Time 2 (for all p , F , R^2 , β , and CI values cited in this section, see Tables 5, 6, & 7). In contrast, when inattention was also a predictor in the model, hyperactivity/impulsivity symptoms were not associated with increased social isolation. Instead, higher levels of hyperactivity-impulsivity symptoms were often associated with decreased social isolation once inattention was controlled.

Analyses of social isolation measures at Time 3 yielded a somewhat different pattern of results. Only one parent-rated measure of social isolation was significantly correlated with inattention and hyperactive/impulsive symptoms, and associations with inattention were consistently smaller in magnitude than in the first two assessments. Only two measures of social isolation at Time 3 were significantly correlated with ADHD symptoms, thus only a couple of regressions were conducted. For a parent-rated measure of social isolation and self-rated loneliness, the overall models were not significant and neither of the individual symptom dimensions were significant predictors.

At Time 1, there was a positive interaction between inattention and hyperactivity such that increasing levels of inattention at various levels of hyperactivity/impulsivity predicted

increased parent-rated social isolation, and parent and teacher ratings of being ignored by peers. No interactions were significant at Time 2 or Time 3.

Subtype Comparisons. ADHD-C and ADHD-I children were significantly more socially isolated and withdrawn than comparison children with the exception of self-reported withdrawn behavior, and the effects were all in the moderate to large range (for all models discussed in this section see Tables 8 & 10 for raw means and standard deviations and Tables 9 & 11 for Cohen's *d*). In contrast, the ADHD-H group was only more significantly impaired than comparison children on a measure of parent rated social isolation and a teacher rating of being ignored by peers. ADHD-C and ADHD-I were each significantly more socially isolated than ADHD-H for all measures except self-rated withdrawn behavior and loneliness, but there were few significant differences between ADHD-C and ADHD-I. ADHD-C was significantly more impaired than ADHD-I for parent-rated social isolation and parent-rated being ignored by peers, and marginally significantly more impaired than ADHD-I for teacher ratings of shy/withdrawn behavior. The pattern of group differences compared to control was similar for Time 2 data. ADHD-C was significantly more impaired than comparison groups on all measures, but teacher rated shy/withdrawn behavior and self-rated withdrawn behavior and loneliness, and ADHD-I was significantly more impaired than comparison groups on all measures but self-rated withdrawn behavior. There were no significant differences between ADHD-C and ADHD-I on any measures of social isolation and withdrawal at Time 2.

Intellectual Functioning. The interactions predicting parent rated social isolation and parent rating of being ignored by peers were no longer significant after controlling for estimated IQ at Time 1. All other effects remained the same after controlling for estimated IQ. No effects changed after controlling for estimated IQ at Time 2 and 3 for symptoms. No effects changed at Time 1 or 2 for subtypes.

Comorbid Psychopathology. When multiple regressions were run controlling for mean severity of ODD symptoms, the only effect that changed was at Time 2, where

hyperactivity/impulsivity was no longer a significant predictor of parent-rated social isolation. Consistent with the symptom dimension results, ADHD-H is no longer significantly different than the comparison group on most measures of social isolation after controlling for ODD symptoms. Additionally, differences between ADHD-I and ADHD-C with respect to withdrawal and social isolation are no longer significant after controlling for ODD symptoms. When controlling for parent-ratings of internalizing symptoms at all time points, the only change was that hyperactivity/impulsivity was no longer a significant predictor of being ignored by peers. After controlling for symptoms of depression, the differences in withdrawal and social isolation between ADHD-I and ADHD-C were no longer significant. For parent-rated withdrawn behavior, ADHD-C and ADHD-I were no longer significantly different from the comparison group after controlling for depression at both time points.

Sex. After splitting the sample by sex and running multiple regressions, there were no differences in the pattern of results at any of the time points for males. For females, there were no differences in the results except that only inattention predicted increased social isolation at Time 1, and inattention did not predict teacher ratings of being ignored by peers at Time 2. There were no changes to effects for females at Time 3.

Cognitive Empathy

Both inattentive and hyperactive/impulsive symptoms had a strong positive correlation with parent-rated measures of social cognition at Time 1 and parent- and teacher-rated measures of social cognition at Time 2 (for all Pearson r values cited in this section, see Tables 5, 6, & 7). Both inattention and hyperactivity/impulsivity independently predicted parent-rated social cognition deficits at Time 1 and Time 2, and the effects were not significantly different (for all p , F , R^2 , β , and CI values cited in this section, see Tables 5, 6, & 7). Further, significant positive interactions between inattention and hyperactivity/impulsivity indicated that, at various levels of severity of inattention, increasing severity of hyperactivity/impulsivity produces greater

deficits in cognitive empathy. In contrast, only inattention predicted teacher-rated social cognition deficits at Time 2.

Both symptom dimensions were significantly correlated with the more in-depth measures of cognitive empathy administered at Time 3. In contrast to findings at the earlier time points, however, hyperactivity/impulsivity was the only significant independent predictor of parent ratings of difficulty understanding social situations. Further, only inattention was associated with social behaviors that are not optimally tuned to the situation. At Time 3, only one model had a significant interaction, and that was the model predicting parent-rated difficulty understanding social situations. The interaction term had a positive coefficient suggesting that while inattentive symptoms alone do not predict increased impairment in understanding social situations, having inattention in addition to hyperactivity increases difficulty as compared to just hyperactivity alone.

Subtype Comparisons. All ADHD subtypes were significantly more impaired than the comparison group on all measures of social cognition at Time 1 and Time 2 (for all models discussed in this section see Tables 8 & 10 for raw means and standard deviations and Tables 9 & 11 for Cohen's *d*). Groups with ADHD-C and ADHD-H were more impaired than the group with ADHD-I on parent ratings of social cognition at Time 1, and the difference between ADHD-C and ADHD-I remained significant at Time 2. In contrast, groups with ADHD-C and ADHD-H were not significantly different at Time 1 and only marginally significantly different from ADHD-H at Time 2. No ADHD subtype was significantly different from the other for teacher rated social cognition.

Intellectual Functioning. Controlling for estimated IQ did not change the pattern of results for any models of cognitive empathy at Time 1 or Time 2. At Time 3, inattention no longer predicted having behavior not optimally tuned to the situation. There was no change in the pattern of results for ADHD subtypes by prosocial behaviors at Time 1 or Time 2

Comorbid Psychopathology. When multiple regressions were run controlling for mean severity of ODD symptoms, the pattern of results did not change at Time 1. At Time 2, hyperactivity/impulsivity was no longer a significant predictor of parent-rated social cognition, and both interactions were no longer significant after controlling for ODD symptoms. Marginally significant predictors lost their significance at Time 3, likely due to low power to detect small effects. There were no changes to the relationship between ADHD subtypes and social cognition after controlling for ODD symptoms.

There was no change in the relationship between inattention and hyperactivity/impulsivity and social cognition after controlling for parent-rated internalizing symptoms at all three time points. This was also true for Time 1 and 2 with the exception that ADHD-I and ADHD-H are not significantly different with respect to both aspects of empathy after controlling for depression.

Sex. After splitting the sample by sex and running multiple regressions, there were no differences in the pattern of results at Time 1, 2, or 3.

Affective Empathy

With respect to affective empathy, both inattention and hyperactivity/impulsivity were moderately correlated with increased callous and narcissistic behavior as rated by parents at all three time points (for all Pearson r values cited in this section, see Tables 5, 6, & 7). However, multiple regression analyses suggest that the symptom dimensions may relate differentially to these two aspects of affective empathy (for all p , F , R^2 , β , and CI values cited in this section, see Tables 5, 6, & 7). When both symptom dimensions were included in the model, inattention was significantly associated with callous/unemotional traits at all three time points, whereas the relation with hyperactivity-impulsivity was only significant at Time 3 after symptoms of ODD were also controlled at Time 1. In contrast, associations with narcissism were generally stronger for hyperactivity-impulsivity than inattention.

Additional measures of affective empathy were also collected at Time 3. Both symptoms dimensions were significantly inversely correlated with the parent-rated empathy quotient, but only inattention was a marginally significant independent predictor of empathy on this measure. Neither inattention nor hyperactivity/impulsivity was significantly correlated with self-rated empathic concern. No interactions between inattention and hyperactivity/impulsivity were significant predictors of affective empathy at Time 3.

Subtype Comparisons. All three ADHD subtypes were rated as having increased parent-rated callous/unemotional and narcissistic traits as compared to controls at Time 1, though the effect was only marginal for ADHD-H. Comparisons among the subtypes at Time 1 were consistent with the findings for the symptom dimensions. Subtypes with elevations of hyperactivity-impulsivity (ADHD-C and ADHD-H) exhibited more narcissistic behaviors than individuals with ADHD-I, whereas subtypes with elevations of inattention (ADHD-I and ADHD-C) exhibited higher levels of callous/unemotional traits. At Time 2, ADHD-C and ADHD-I are rated to have significantly more callous and narcissistic behavior than the comparison group. However, there is no significant difference between the two diagnostic groups at Time 2.

Intellectual Functioning. Controlling for estimated IQ did not affect the pattern of results for affective empathy as measured at any time point for symptom dimensions or subtypes.

Comorbid Psychopathology. When multiple regressions were run controlling for mean severity of ODD symptoms, inattention was no longer a significant predictor for callous behavior at both Time 1 and 2. Neither inattention nor hyperactivity/impulsivity were significant predictors of narcissism at Time 2 after controlling for ODD symptoms. No other effects were changed at Time 1 and 2. Once again any significant predictions at Time 3 were no longer significant after controlling for ODD symptoms, and this was likely due to low power to detect these effects in the sample. Controlling for ODD symptoms did not change the differences in callous traits

between the ADHD subtypes with each other or with the comparison group, but it did eliminate all significant differences among all groups on narcissism.

When controlling for parent-ratings of depression at Time 2, inattention no longer predicted impaired affective empathy. In contrast, controlling for internalizing symptoms at Time 3 caused a very marginal effect between hyperactivity/impulsivity and affective empathy to become nonsignificant. There were no changes at Time 1 after controlling for either depression or anxiety. There were no changes in subtype relationships at Time 1 or 2 when controlling for depression.

Sex. After splitting the sample by sex and running multiple regressions, the results generally remained the same for affective empathy. An exception to this is that hyperactivity/impulsivity was no longer a significant predictor in males at Time 1, though it remained significant at Time 2. The opposite pattern was apparent for inattention, which no longer predicted decreased affective empathy for males at Time 2, though it did at Time 1. There was no change in effect for Time 3.

Family Relationships

At Time 2, the CBCL and YSR were administered, which allowed for the opportunity to examine family relationships as rated by parents and children. ADHD symptoms were associated with greater difficulty in family relationships as rated by parents and only sibling relationships for self-rated measures (for all Pearson r values cited in this section, see Table 6). Follow up with multiple regressions for the measures of family relationships that were significantly correlated with ADHD symptoms, indicated that across all measures and regardless of rater, inattentive symptoms were significantly associated with increased impairment in those relationships while hyperactivity/impulsivity was not (for all p , F , R^2 , β , and CI values cited in this section, see Table 6). There were two marginally significant negative interaction effects for parent-rated family relationships and self-rated sibling relationships.

Subtype Comparisons. When comparing diagnostic groups on family relationship measures at Time 2, there was only one significant difference between each diagnostic group and the control group. Parent rating of how well the child “gets along” with their family is significantly more impaired for ADHD-C than comparison children; this is a large effect. There were no differences between ADHD-C and ADHD-I on all measures of family relationships.

Intellectual Functioning. There were no changes to the pattern of results for family relationships measured at Time 2 after controlling for estimated IQ or for subtype relationships at Time 2 after controlling for IQ.

Comorbid Psychopathology. When multiple regressions were run controlling for mean severity of ODD symptoms, inattention was no longer a significant predictor of parent rating of how the child “gets along” with the family and self-rating of how the child “gets along” with their siblings. The interaction between inattention and hyperactivity/impulsivity for these same models was no longer significant after controlling for ODD symptoms. After controlling for ODD symptoms, there were no significant differences among the ADHD subtypes and the comparison group. When controlling for parent-ratings of depression at Time 2, inattention was no longer a predictor of most family functioning measures. There were no significant differences among subtypes for family relationships and this effect persisted after controlling for depression and anxiety.

Sex. After splitting the sample by sex and running multiple regressions, there were differences in the pattern of results. In males, for parent-report of getting along with family and self-report of sibling relationships, inattention was no longer significant. For females, hyperactivity/impulsivity no longer significantly predicted parent report of getting along with family.

Other Social Impairment

Both inattentive and hyperactive/impulsive symptoms were associated with an increase in other types of social impairment at both Time 1 and Time 2 (for all Pearson r values cited in

this section, see Tables 5 & 6). For example, both symptom dimensions were moderately correlated with increased impairment in interactions with other adults or teachers and staff at school as rated by parents and teachers. When children rated themselves on social problems, increased inattentive symptoms were more highly correlated with increased social problems than were hyperactive/impulsive symptoms at Time 1 whereas at Time 2 they had the same strength of association. These measures were not collected at Time 3, thus no data is available.

For all of these measures of social impairment at Time 1 and 2, multiple regressions indicate inattention and hyperactivity/impulsivity both significantly and independently predict increased impairment with a few exceptions (for all p , F , R^2 , β , and CI values cited in this section, see Tables 5 & 6). Hyperactivity/impulsivity does not significantly predict self-rated social problems at Time 1, and neither symptom dimension significantly predicts self-rated social problems at Time 2. At Time 1, there is a significant positive interaction between inattention and hyperactivity/impulsivity for all parent- and teacher-rated measures of social impairment with other adults in the community and school setting. At Time 2, there is only one marginally significant positive interaction predicting increased impairment with school staff as severity increases on one dimension at each level of severity on the other symptom dimension.

Subtype Comparisons. All subtypes were significantly impaired compared to controls for all measures of other types of social impairment at Time 1 and Time 2, except for ADHD-H on self-rated social problems. At Time 1, ADHD-C was significantly more impaired than ADHD-I and ADHD-H on all measures except for self-rated social problems at Time 1. ADHD-I was significantly more impaired than ADHD-H for impairment in interactions with teachers, but there were no other significant differences at Time 1. At Time 2, ADHD-C was only significantly more impaired with other adults than ADHD-I.

Intellectual Functioning. Controlling for estimated IQ does not affect any results at Time 1 or 2 for symptom dimensions or subtype relationships.

Comorbid Psychopathology. When multiple regressions were run controlling for mean severity of ODD symptoms, the only resulting change was that the marginally significant interaction for the model predicting impairment with school staff was no longer significant. Differences between the ADHD subtypes and comparison groups on other types of social relationships persisted over and above effects of ODD symptoms. When controlling for parent-ratings of depression, there were no changes in the effects at Time 1 or 2. The pattern of results for subtypes remained unchanged after controlling for depression.

Sex. After splitting the sample by sex and running multiple regressions, there were no differences in the pattern of results at Time 1. At Time 2, for females, only inattention predicted impairment with adults in the community and school setting and self-rated social problems. There was no difference in the pattern of results for males at Time 2 or 3.

Longitudinal Analyses

Inattentive and hyperactive/impulsive symptoms measured at Time 1 predicted Time 2 social functioning in the same pattern as Time 2 ADHD symptoms predicting social functioning measured at Time 2. However, the effects were no longer significant after controlling for ADHD symptoms at Time 2, suggesting that the prediction of social impairment at Time 2 was primarily explained by stable ADHD symptoms that remained elevated at Time 2. In contrast, inattention and hyperactivity/impulsivity measured at Time 1 did not significantly predict social functioning at Time 3 with the exception of a few outcome measures: inattention at Time 1 was a marginally significant predictor of loneliness at Time 3 as measured by the UCLA Loneliness scale (a self-report measure), and this effect persisted over and above inattentive symptoms measured at Time 3 ($F=2.79$, $p=0.03$, $\beta=0.54$, $p=0.03$). Hyperactivity/impulsivity at Time 1 was a marginally significant predictor of difficulty with social understanding at Time 3 (as measured by a parent report measure), but this did not hold after controlling for hyperactivity/impulsivity at Time 3. Likely, we are unable to detect effects of Time 1 ADHD on Time 3 social functioning due to the low power in the Time 3 sample at this time.

CHAPTER IV

Discussion

The primary aim of the current study was to systematically examine social functioning in children and adolescents with ADHD and to develop a comprehensive picture of the relationship between ADHD symptoms and the multiple component skills and characteristics required to successfully navigate the social world. This is one of the largest samples ever used to study social functioning in children and adolescents with ADHD, and it is a community sample, which allowed us to examine deficits in a sample representative of the full spectrum of severity of inattention and hyperactivity/impulsivity. Further, it is the most comprehensive battery of social functioning to date and includes measures novel to studying this population.

Overall, the current results corroborate previous findings in the literature that ADHD symptoms in children are associated with significant impairment in overall social functioning (e.g., Willcutt et al., 2012; McQuade & Hoza, 2008). More specifically, associations with ADHD symptoms were strongest for prosocial behavior and social skills, impairment with peers and adults, social cognition, and aggression. Associations with ADHD were significant but weaker for more specific aspects of social functioning, such as social acceptance and rejection, social isolation and withdrawal, affective empathy, and family relationships. While not all of the novel measures administered in this study had significant results, it was encouraging to find that particular subscales measuring specific components of social functioning were significantly associated with ADHD symptoms and were uniquely predicted by at least one symptom dimension. For example, two subscales of the CSBQ demonstrated a differential association with inattention predicting being not out of tune with social situations and hyperactivity/impulsivity predicting having difficulty understanding social situations. This suggests that the items on these scales may be useful for identifying specific social deficits in an ADHD population even though this measure was designed for use with an autism spectrum disorder population.

Symptom Dimension and Subtype Differences

A second primary aim of this study was to add to the literature on the validity of DSM-IV and DSM-5 ADHD in children and adolescents by examining the relations between ADHD symptom dimensions and subtypes and an extensive battery of measures of social functioning. As expected, both symptom dimensions were significantly correlated with all measures of social impairment. Further, both dimensions independently predicted most measures of social impairment in multiple regression models, although there were differential findings with respect to the strength and direction of the effects. As predicted, children with greater severity of hyperactive/impulsive symptoms exhibited increased impairment on measures of aggression, whereas elevations of inattention symptoms were associated with increased social withdrawal and less frequent prosocial behavior. In fact, for the most part hyperactivity/impulsivity was not a significant independent predictor of social isolation and withdrawal across the three time points.

In contrast to these initial results that supported our hypotheses, several other results were inconsistent with our original expectations. Contrary to our initial hypothesis that hyperactivity-impulsivity symptoms would be a stronger predictor of social rejection, the symptom dimensions had similar associations with a range of ratings of acceptance and rejection by peers. Further, when any slight differences between the effects emerged, the effect was significantly stronger for inattention than hyperactivity/impulsivity. Similarly, we found that inattentive symptoms more strongly predicted callous and unemotional behavior, although hyperactive/impulsive symptoms more strongly predicted narcissism. Overall, these data provide an important contribution to the literature supporting the concurrent validity of the two symptom dimensions described in DSM-IV and DSM-5, and bolsters the sparse literature demonstrating discriminant validity of the two symptom dimensions on measures of social functioning.

There was a similar pattern of results for differential functioning by ADHD subtype. Generally, an ADHD diagnosis results in increased impairment on all measures of social functioning, and differences among the subtypes on the measures of social functioning tended to be quantitative differences in severity rather than qualitative differences in type of impairment. Across most measures of impairment, ADHD-C was more impaired than either ADHD-I or ADHD-H, and generally ADHD-C and ADHD-H were more disparate with the exception of on the measures of aggression where there was a larger difference in effect size between ADHD-C and ADHD-I. Generally, there are few significant differences between the ADHD-I and ADHD-H subtypes on most measures of social functioning. However, there were some meaningful differences that followed the pattern of results for symptom dimensions: ADHD-I was greatly more impaired than ADHD-H on leadership and social isolation and ADHD-H was more impaired than ADHD-I on social cognition and narcissism. Additionally, the ADHD-C subtype is generally the most impaired of the three subtypes as neither the ADHD-I nor the ADHD-H subtype was more strongly associated with any measure of impairment than the ADHD-C subtype. With respect to social functioning, the data are counter to suggestions that children classified as ADHD-I may present with unique inattentive symptoms not present in children with ADHD-C that cause differential impairment (e.g., R. A. Barkley, 2001; Milich, Balentine, & Lynam, 2001).

Overall, the data suggest that both DSM-IV ADHD symptom dimensions and nominal subtypes possess concurrent and discriminant validity. Both inattention and hyperactive/impulsive symptoms independently lead to clinically significant impairment, suggesting that both dimensions are necessary to fully describe the symptoms and impairment that characterize ADHD. Further, the current results indicate that we cannot throw out the ADHD-H subtype, because children classified as that subtype are experiencing increased impairment compared to comparison children. The literature demonstrates that the ADHD-H subtype is associated with inconsistent academic and neuropsychological deficits, thus social

deficits may be an area for which ADHD-H shows consistent impairment thereby contributing to establishing the validity of this subtype. However, it is not clear that this result is consistent over and above comorbid symptoms, such as oppositional behavior.

Contributions of IQ, comorbid psychopathology, sex, and age

When estimated intellectual functioning was controlled, most relationships between ADHD symptoms and social functioning did not change. One of the few findings that did change suggested that ADHD symptoms may not significantly predict whether a child is disliked by peers later in life after IQ is controlled. Similarly, the significant association between inattention and aggression early in life may be explained by individual differences in intellectual functioning. With these exceptions, IQ did not seem to explain the strong associations between ADHD symptoms and social dysfunction.

The presence of comorbid psychopathology appeared to have variable effects on the relationship between symptoms of ADHD and social functioning. The most striking effect was at Time 1 where inattention no longer predicted any measure of aggression after controlling for comorbid externalizing and internalizing symptoms. This pattern did not manifest at the other two time points, which may indicate the presence of a complex interaction between age, ADHD symptoms, and aggressive behavior. Further, inattention was no longer a significant predictor of affective empathy or poor family relationships after controlling for symptoms of ODD, while hyperactivity/impulsivity was no longer a significant predictor of several measures of friendship after controlling for ODD symptoms. However, the relationship between ADHD symptoms and prosocial behaviors, social isolation, and cognitive empathy were broadly unchanged after controlling for both externalizing and internalizing behaviors.

These results are consistent with the hypothesis that ADHD symptoms may not predict aggression over and above externalizing symptoms. However, these results are somewhat contrary to previous literature demonstrating that overall ADHD symptom dimensions significantly predict increased social impairment over and above symptoms of ODD, anxiety and

depression (e.g., Abikoff et al., 2002; Graziano, Geffken, & McNamara, 2011). The results of this study continue to support the validity of the ADHD diagnosis by demonstrating that these symptoms uniquely contribute to deficits in social functioning and the observed impairment is not always better accounted for by comorbid symptoms. The results also suggest that in future studies it will be important to control for comorbid psychopathology and investigate possible interactions between symptoms of ADHD with comorbid psychopathology for particular aspects of social functioning.

Running the regressions in samples separated by sex demonstrated few differences in males and females. The failure to find significant sex differences is somewhat surprising given the consistent sex difference in the prevalence of ADHD (approximately 2:1 male:female in community samples; e.g., Willcutt, 2012), but these results are consistent with an extensive literature that suggests that the correlates of ADHD are very similar in males and females with ADHD despite the significant difference in prevalence (e.g., Hartung et al., 2002). Additionally surprising was that we did not find a differential relationship between ADHD symptoms and relational aggression for males and females at the first two time points, but we found that ADHD symptoms were only significantly correlated with relational aggression for females at Time 3 and this was not the case for males. This is one of the few sex differences found in the literature, so we might have expected it to be present in all of our sample (Zalecki & Hinshaw, 2004).

When looking across the three time points, results were similar and there were no striking differences in the pattern of results for each time point. This was not consistent with the hypothesis that social interactions might be more difficult at an older age due to the increased sophistication.

Strengths, Limitations, and Future Directions

The use of two large community samples was an important strength of the study. The large sample allowed us to detect subtle yet important effects of ADHD symptoms on the social lives of affected children, and provided adequate statistical power to test for differential results

between the symptom dimensions and diagnostic subtypes. These findings also provided a framework to begin to interpret the marginally significant results at Time 3, even though there was not enough power to detect some of the smaller effects in that sample.

Another strength of our study is the fact that we used a community sample as opposed to a clinic-referred sample as has been done in much of the rest of the literature. This allows us to demonstrate that social impairment is common and significantly impairing to all children experiencing elevated rates of inattentive and hyperactive/impulsive symptoms, regardless of whether they are presenting for treatment.

A third key strength of this study is the comprehensive battery of measures administered to participants. This extensive battery facilitated a more nuanced and in depth examination of social functioning in individuals with ADHD. However, the current measures also have important limitations. Additional research is needed to validate several measures as a “gold standard” measure of the relevant social construct. For example, some of our measures had better face validity for younger children than for adolescents, or appeared to be most appropriate for children with a severe presentation of social deficits such as autism spectrum disorder. Future studies are needed to refine and validate these instruments as psychometrically sound measures of different aspects of social impairment in the general population and specific clinical groups. Additionally, innovative new approaches to social measurement such as objective measures could also improve our accuracy in understanding social difficulties in children with symptoms of ADHD. For example, in vivo observation of social interactions with novel peers and participation in online chat rooms (e.g., Hodgins et al., 2000; Mikami et al., 2007).

Another strength of this study is inclusion of ratings of ADHD symptoms and social functioning by various raters: parent, teacher, and self. This study found similar results across all three time points, even though there were different combinations of raters used at each time point, which suggests that there are not large rater effects. However, future studies directly

comparing differences between the ADHD symptoms and social functioning outcomes as a function of the rater would provide an important contribution to the literature by refining our understanding of the unique contributions of different raters.

Another important limitation of the current study was the small number of participants collected thus far at Time 3. This restricted our ability to make strong conclusions about social functioning at this later time point in development and to create more sophisticated causal models. Thus, a key future direction for this study is to continue collecting data at Time 3 to provide sufficient statistical power for more sophisticated statistical methods such as structural equation modeling. These methods would allow us to begin to test the direction of causality of ADHD symptoms and social functioning throughout development.

An interesting question that could be addressed with path analysis is whether all of these aspects of social functioning are resulting from ADHD symptoms directly or rather whether some are steps in a causal pathway to certain types of social dysfunction. For example, perhaps peer rejection is resulting directly from a child's inability to control impulses, intrusion on other people's conversation, and inability to stay engaged for any period of time. In contrast, if social interaction is not rewarding due to peer rejection, this might then lead to withdrawal from social interactions, rather than a direct association between withdrawal and symptoms of inattention or hyperactivity/impulsivity per se. Further, executive function may mediate the relationship between ADHD status and social functioning outcome measures. The literature demonstrates mixed results with respect to the relationship between executive function and social deficits in children with ADHD (Huang-Pollock et al., 2009; Perner, Kain, & Barchfeld, 2002; Wahlstedt et al., 2008; Diamantopoulou, Rydell, Thorell, & Bohlin, 2007; Rinsky & Hinshaw, 2011; C. Clark, Prior, & Kinsella, 2000), which indicates this as a potentially important area for further study. In combination with the rich datasets collected at Time 1, a larger sample at Time 3 will provide a unique opportunity to begin to properly test these types of models,

facilitating the development of a comprehensive model of social functioning in children and adolescents with ADHD.

Conclusions

The current findings clearly indicate that ADHD is associated with significant impairment in most social domains. Notably, children with ADHD are less well-liked by peers, more actively disliked by peers, are ignored and experience more social isolation than peers, and are more aggressive than peers. The data from this study suggests that children with ADHD may also have deficits in both cognitive and affective empathy, but further study is required. Importantly, the demonstrated social impairment is not better accounted for by symptoms of other disorders that are often comorbid with ADHD.

These findings also provide important support for the concurrent and discriminant validity of the DSM-IV inattention and hyperactivity-impulsivity symptom dimensions and diagnostic subtypes. Both dimensions independently and differentially predict various aspects of social impairment, indicating that both dimensions are required for a valid definition of ADHD.

Overall, the current study provides an additional contribution to a comprehensive model of social functioning in ADHD. Ultimately, these results may improve clinical practice by facilitating increasingly accurate differential diagnosis between ADHD and other childhood psychopathology classically thought to be disorders of social function, such as Autism Spectrum Disorder and Conduct Disorder. Further, a more comprehensive model of social functioning is likely to facilitate the identification of appropriate targets for intervention, eventually leading to significant improvements in the quality of life of individuals with ADHD.

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