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Developmental Trajectories of Aggression, Prosocial Behavior, and Social-Cognitive Problem Solving in Emerging Adolescents with Clinically Elevated ADHD Symptoms

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Abstract

Middle school is a critical yet understudied period of social behavioral risks and opportunities that may be particularly difficult for emerging adolescents with ADHD given their childhood social difficulties. Although childhood ADHD has been associated with increased aggression and peer relational difficulties, relatively few ADHD studies have examined social behavior beyond the elementary years, or examined aspects of positive (prosocial) behavior. In addition, social-cognitive problem solving has been implicated in ADHD; however, its longitudinal impact on prosocial and aggressive behavior is unclear. The current study examined how middle school students with clinically elevated ADHD symptoms differ from their non-ADHD peers on baseline (sixth grade) and age-related changes in prosocial and aggressive behavior, and the extent to which social-cognitive problem solving strategies mediate these relations. Emerging adolescents with (n = 178) and without (n = 3,806) clinically elevated, teacher-reported ADHD inattentive *and* hyperactive/impulsive symptoms were compared longitudinally across sixth through eighth grades using parallel process latent growth curve modeling, accounting for student demographic characteristics, ODD symptoms, deviant peer association, school climate, and parental monitoring. Sixth graders with elevated ADHD symptoms engaged in somewhat fewer prosocial behaviors (d= −0.44) and more aggressive behavior (d= 0.20) relative to their peers. These small social behavioral deficits decreased but were not normalized across the middle school years. Contrary to hypotheses, social-cognitive problem solving was not impaired in the ADHD group, and did not mediate the association between ADHD and social behavior during the middle school years. ADHD and social-cognitive problem solving contributed independently to social behavior, both in sixth grade and across the middle school years; the influence of social-cognitive problem solving on social behavior was highly similar for the ADHD and non-ADHD groups.

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Keywords

ADHD; aggression; prosocial; social cognition; problem solving; middle school

Extant research suggests that childhood ADHD symptoms convey risk for difficulties in both negative and positive aspects of interpersonal interactions (Bagwell et al., 2001; Griggs & Mikami, 2011). Despite the well-documented adverse outcomes associated with social behavioral difficulties, relatively little is known about the developmental trajectory of these difficulties beyond the elementary years, or the underlying factors responsible for these behavioral patterns in emerging adolescents with clinically elevated ADHD symptoms. Tracking these children's social behavior beyond elementary school is critical given developmental increases in problem behavior and decreases in prosocial behavior in middle school among the general population (Bongers et al., 2003), combined with evidence that middle school is associated with significant disruption in the developmental course of ADHD symptoms (Langberg et al., 2008). The goal of the current study is to examine the impact of ADHD status on the developmental trajectories of aggressive and prosocial behavior across the middle school years, track the mediating role of social-cognitive problem solving in explaining social behavioral difficulties (Dodge et al., 2013), and consider potential additional or alternative explanations for age-related changes in social behavior for middle schoolers with clinically elevated ADHD symptoms. In the ensuing sections, we review middle school's changing social landscape, followed by an overview of social-cognitive mechanisms and processes associated with middle school social behavior. Within this context, we discuss social-cognitive problem solving's role in social functioning for children and adolescents with ADHD, focusing specifically on both negative and positive aspects of social behavior.

The Middle School Context

Emerging adolescence is associated with changes across myriad developmental domains and increased risk for diminishment in social behavioral functioning (Arnett, 1999). Increasing time away from family, shifts in neurocognitive development, and greater expectations of personal responsibility are among the major changes associated with this time (Meyer et al., 2004; Steinberg, 2009). Peer relationships emerge as primary influences on behavior and evolve to include new types of relationships (e.g., dating; Rubin et al., 2006), and prosocial peer interactions become increasingly predictive of healthy emotional development (Wojslawowicz et al., 2006). At the same time, middle school is a time of increased risk for serious negative consequences from aggressive behavior, emotional distress, and peer victimization (Kofler et al., 2011; Pellegrini & Long, 2002). It is a time when social abilities thought to differentiate students with ADHD are challenged, including the ability to plan, judge, and manage conflict, multiple relationships, and direct behavior to navigate complex social demands (Phillips et al., 2004).

ADHD in middle school

Multiple studies have documented that middle school marks a drop off in aspects of positive social behavior and academic engagement (Wang & Eccles, 2012). It is thought that the

incumbent transitions and increasing complexity of demands on self-control and social engagement would make this developmental period particularly difficult for emerging adolescents with disorders such as ADHD that are already associated with childhood social behavioral and social-cognitive difficulties (Sibley et al., 2010). It is clear that most children with ADHD continue to manifest the disorder in adolescence and adulthood (Barkley et al., 2006), and their transition to middle school appears to be associated with social and behavioral difficulties beyond those associated with normal development. For example, middle school is associated with a disruption in the developmental decline of inattentive and hyperactive/impulsive symptoms (Langberg et al., 2008), increased rates of deviant peer affiliation (Marshal et al., 2003), the emergence of significant comorbidity with depression (Wolraich et al., 2005), and continued peer relational difficulties (Bagwell et al., 2001) among those with ADHD identified in elementary school.

At the same time, a developmental shift in peer perceptions of disruptive behavior occurs - whereas disruptive behaviors were viewed as generally aversive to peers in childhood (Erhardt & Hinshaw, 1994), these behaviors become either unrelated or even positively related to peer acceptance in adolescence (Bukowski et al., 2000; Salmivalli et al., 2000). In addition, risk-taking typically increases across the population (Phillips et al., 2004). These patterns of findings, when considered together, suggest potentially important developmental changes in the relation between ADHD and social dysfunction. It seems valuable to attempt to track the relation of social behavioral functioning and social-cognitive features associated with ADHD through this critical middle school period (Sibley et al., 2010). In particular, understanding the mechanisms and processes associated with social behavior for emerging adolescents with ADHD will be critical for identifying novel treatment targets given the inefficacy of social skills training for childhood ADHD (Evans et al., 2013). To our knowledge, however, no study to date has investigated the developmental trajectory of social behavioral and social-cognitive functioning for middle schoolers with ADHD during this critical developmental period.

Mechanisms and Processes Affecting Middle School Social Behavior

According to the social information processing model, social behavior is a function of capabilities, social knowledge, social-cognitive problem solving abilities, and environmental influences (Dodge et al., 2013). Social-cognitive problem solving is defined as the processes through which we evaluate and select potential responses to social information, and includes the encoding, storage, retrieval, processing, and application of relevant information to social situations (Phillips et al., 2004; Sibley et al., 2010). Importantly, poor social-cognitive problem solving predicts growth in aggressive behavior across childhood and adolescence, even when previous behavior is controlled (Dodge, Pettit, Bates, & Valente, 1995). Relatively few studies have focused on middle school specifically (Phillips et al., 2004); however, the importance of social-cognitive problem solving during middle school can be inferred by studies predicting high school social functioning from elementary school social-cognition. For example, Dodge and colleagues (2013) found that aggressive and competent/nonviolent problem-solving tendencies prior to middle school (Grades 1–5) were associated prospectively with social behavior after middle school (Grade 9), and competent/nonviolent problem-solving tendencies mediated the effects of an elementary school violence

prevention program on aggressive behavior in high school (Dodge et al., 2013). The current study bridges this gap, examines the developmental interrelations among social behavior (aggressive and prosocial) and social cognitive problem-solving (aggressive and competent/nonviolent problem solving tendencies) across the middle school years, and tests whether these relations differ for middle schoolers with clinically elevated ADHD symptoms.

ADHD, Social Behavior, and Social Cognition in Middle School

Social behavior

Social behavioral difficulties among children with ADHD are well documented (de Boo & Prins, 2007; Huang-Pollock et al., 2009), and the limited available evidence suggests that these difficulties continue into adolescence (Bagwell et al., 2001) and adulthood (Friedman et al., 2003) for many individuals with ADHD. For example, elementary-aged children with ADHD are viewed as more aggressive and more likely to bully their peers (Bacchini et al., 2008; Holmberg & Hjern, 2008; Unnever & Cornell, 2003), although the evidence is mixed regarding the extent to which this association is attributable to ADHD or co-occurring oppositional defiant (ODD) symptoms (Stormshak et al., 1999). In contrast, very few studies have reported on prosocial behavior in children with clinically elevated ADHD symptoms. Prosocial behavior refers to positive social overtures to benefit others; operational definitions include a variety of social behaviors such as helping others, social compliance, initiation of contact, norm setting, leadership, and mediation of conflict (Erhardt & Hinshaw, 1994). The scant available evidence suggests that children with ADHD display fewer prosocial actions during initial interactions with unfamiliar peers (Erhardt & Hinshaw, 1994). In contrast, Huang-Pollock and colleagues (2009) reported no significant differences in prosocial comments during an online chat room task between children with and without ADHD. These somewhat mixed results suggest that prosocial behavior may be an important yet understudied factor for understanding social functioning as children with ADHD progress into middle school and beyond.

To our knowledge, no study to date has examined prosocial behavior in adolescents with ADHD. This paucity is surprising given the longitudinal association between social behavior and adverse functional outcomes associated with ADHD symptoms (Stormshak et al, 1999). Developmentally, engagement in prosocial behaviors is linked to emotional well-being and identity development (Berndt & Hoyle, 1985; Bowker et al., 2006), and positively predicts peer friendship ratings, over and above the impact of aggressive behavior (Erhardt & Hinshaw, 1994). In particular, prosocial behavior merits more attention and may add to our understanding of ADHD-related social functioning in emerging adolescence beyond that gained from simply considering negative or aggressive behavior (MVPP, 2008). As such, a notable gap in the evidence base is the absence of data regarding the developmental trajectory of prosocial behavior among emerging adolescents with ADHD.

Social-cognitive problem solving

Recent research suggests that social-cognitive problem solving may be a key, yet understudied, area of impairment in childhood ADHD; however, relatively little is known about the developmental continuity of these difficulties beyond the elementary years. In

childhood, the evidence is mixed, with some studies reporting medium magnitude impairments on tasks measuring the ability to generate or endorse socially appropriate strategies (d = 0.66; Zentall et al., 2001), and other studies reporting more modest effects (d = .01 to .37; Maedgen & Carlson, 2000; Marton et al., 2009; Melnick & Hinshaw, 1996). Additional studies suggest an association between childhood ADHD symptoms and subprocesses involved in prosocial and aggressive strategy generation (Andrade et al., 2012; Huang-Pollock et al., 2009; Lorch et al., 2000, 2004; Maedgen & Carlson, 2000; Marton et al., 2009) that appear robust to common comorbidities and factors such as ODD symptoms, language abilities, and IQ (Marton et al., 2009). Importantly, impaired social-cognitive problem solving in children diagnosed with ADHD predicts parent, teacher, and peer endorsements of children's social status (Maegden & Carlson, 2000; Melnick & Hinshaw, 1996) – providing some evidence of convergence between the ADHD and developmental literatures regarding social-cognitive mechanisms associated with social behavioral functioning (Dodge et al., 2013).

To our knowledge, only one study to date has examined social-cognitive problem solving in middle schoolers with ADHD. Sibley and colleagues (2010) found that emerging adolescents with ADHD were significantly less likely to endorse competent/nonviolent solutions to hypothetical social situations (d = 0.91), and – similar to studies of elementary school children – observed a cross-sectional link between maladaptive social cognition and parent-reported social impairment. Collectively, the available evidence suggests that social-cognitive problem solving difficulties may begin in childhood (Maegden & Carlson, 2000), become increasingly apparent in emerging adolescence (Sibley et al., 2010), and reflect a key mechanism underlying previously reported social behavioral difficulties. The present study tests these hypotheses by examining the longitudinal association among these important areas of social functioning during emerging adolescence. The middle school years were specifically chosen as they represent the nexus of trajectory changes in problematic and prosocial behavior (MVPP, 2004), and are associated with significant disruption in the developmental course of ADHD symptoms (Langberg et al., 2008).

Current Study

The goal of the current study was to examine the impact of ADHD status and social-cognitive problem solving on aggressive and prosocial behavior in a large, multisite, longitudinal sample of middle school children. Two cohorts (n = 4,796) from 37 schools across four communities (Multisite Violence Prevention Project [MVPP], 2004, 2008, 2009) were followed from the beginning of sixth grade to the end of eight grade. Analyses were conducted using parallel process latent growth curve modeling (LGM), which is a structural equation modeling–based approach for longitudinal data that explicitly controls for measurement error, cohort effects, and site effects (clustering) while allowing age-related symptom changes to serve simultaneously as predictors and indicators of other variables (Cheong et al., 2003; Muthen & Curran, 1997). The study has three major purposes related to understanding ADHD, prosocial and aggressive behavior, and social-cognitive problem solving during the middle school years:

1. To test the impact of social-cognitive problem solving on initial levels (intercept) and age-related changes (slope) in aggressive and prosocial behavior during the middle school years, controlling for factors known to impact social behaviors.
2. To test the extent to which ADHD status is associated with variation in initial levels (baseline) and age-related changes (slope) in aggression, prosocial behavior, and social-cognitive problem solving.
3. To test the extent to which the associations between ADHD status and aggressive and prosocial behavior are explained (mediated) by social-cognitive problem solving, both in sixth grade and across the middle school years.

Method

Participants

The current data were collected within the context of a large, violence prevention study involving middle school students from two cohorts at 37 schools across 4 communities (MVPP, 2004). Participating schools were recruited from four sites: Chicago, Illinois; Durham, North Carolina; northeastern Georgia; and Richmond, Virginia. All participating schools had high percentages of low income families based on eligibility for the federal free or reduced price lunch program (ranging from 42% to 96% across sites). Across sites 30–78% of the students were African-American and 5–51% were Latino. Two parent family rates ranged from 35% to 58% across sites. Data were collected from a random sample of approximately 80 students per cohort from the rosters of each of the larger middle schools and from all eligible students at the smaller K-8 Chicago schools. Children in self-contained special education classrooms were excluded because the universal intervention was not implemented in these settings. The institutional review boards at the four participating universities and Centers for Disease Control and Prevention (CDC) approved all study procedures. Consent and assent letters were sent home with students. One or more waves of data were available for 5,581 students (99% of those consented and eligible) on student measures and for 5,529 students (98%) on teacher reports.

The Multisite Violence Prevention Project (MVPP, 2004) used a fully-crossed design, with approximately equal numbers of schools assigned to the universal-only, selective-only, combined, and control (no intervention) conditions. The universal program, consisting of student and teacher curriculums, provides instruction and practice in the use of a social-cognitive problem-solving model and instructs students on avoiding dangerous situations, ignoring teasing, asking for help, talking things through, and being helpful to peers. The selective intervention was a family intervention focused on parenting skills and child-parent communication implemented at each randomized school with 15–25 sixth graders identified as both aggressive and socially influential by their teacher (cf. Smith et al., 2004).

Control for Potential Intervention Effects to Evaluate Developmental Trends Across the Middle School Years

Outcome studies suggest that treatment effect sizes were near 0.0 for the current study's social behavior variables ($d = -0.01$ to 0.10; MVPP, 2008). Likewise, the prevention

programs did not significantly impact our social-cognitive problem solving variables (*d* = −0.01 to 0.02; MVPP, 2009).

As the interest here is not intervention effects, MVPP treatment condition was treated as a control in all analyses to allow examination of developmental trends across the middle school years. To accomplish this, three covariates were added to all models: Universal (Yes/No), Selective (Yes/No), and Combined (Yes/No); thus, results reported below reflect developmental trends after accounting for potential intervention effects.

Data Collection Procedures

Students completed measures at school in groups of 10–20 using a computer-assisted survey interview. Student behavior ratings were obtained from one teacher per student at each wave (cf. Miller-Johnson et al., 2004 for detailed descriptions and psychometric properties for all measures). The two cohorts were structurally invariant and showed the same pattern of results when run in separate models; the cohorts were therefore combined in all models.

ADHD status

Given that a comprehensive clinical evaluation was not feasible within the context of the current, large-scale study, emerging adolescents with clinically elevated ADHD inattentive and hyperactive/impulsive behavior symptoms were identified using stringent cut-off criteria based on teacher reports of attention problems and hyperactivity. Developmental cut-off scores based on nationally standardized, normative data were selected as recommended given their improved sensitivity relative to symptom counting methods for longitudinal research (cf. Barkley et al., 1990). These criteria separated the groups by a minimum of 1.0 *SD* on each ADHD symptom cluster as recommended (Barkley et al., 1990). A categorical rather than dimensional approach was selected given our primary goal of refining hypotheses for future research with clinically diagnosed adolescents with ADHD, and balancing generalizability considerations to both clinical and community-based samples of ADHD.

Each child's classroom teacher completed the BASC Adolescent Form (Reynolds & Kamphaus, 1992), a 139-item scale that assesses internalizing and externalizing behavior symptoms and adaptive behavior in children ages 12 to 21. Raw scores are converted to age- and gender-specific T-scores based on the national standardization sample. Specifically, children were assigned to the ADHD-Combined symptoms group if their sixth grade teachers (Time 1) rated them in the 98th percentile or above (i.e., 2 *SD* above the mean; T ≥ 70) on *both* the Attention Problems and Hyperactivity subscales of the BASC (*n* = 178; 3.5% of sample). Conversely, children were included in the non-ADHD group if their teachers rated them within 1.0 *SD* of the mean (T < 60) on *both* the Attention Problems and Hyperactivity subscales (*n* = 3,806; 74.0% of sample). Children whose ratings on one or both subscales fell between 1.0 and 2 *SD*, or who scored at/above 2 *SD* on one but not both subscales, were excluded (*n* = 1,158; 22.5% of sample). Requiring both inattention and hyperactivity/impulsivity symptom clusters (ADHD-Combined) was intended to minimize false positives (Type I error) due to other potential conditions, given the strong symptom

overlap and correlations among each ADHD dimension and other forms of common adolescent psychopathology (Lahey et al., 2008; Youngstrom, Findling & Calabrese, 2003).

Primary Outcome Variables (Social Behavior)

Aggressive behavior—The Problem Behavior Frequency Scale (PBFS; Farrell, Kung, White, & Valois, 2000) was used to obtain students' reports of their frequency of aggression. The 18-item Aggression scale (α = .92) included seven items representing physical aggression (e.g., "been in a fight in which someone was hit"). For each item, students rated how frequently each item happened in the past 30 days using the following 6-point response scale: 1 (Never), 2 (1–2 times), 3 (3–5 times), 4 (6–9 times), 5 (10–19 times), and 6 (20 or more times). Scores on the Physical Aggression scales were log-transformed to reduce skewness and kurtosis.

The BASC Adolescent Form (Reynolds & Kamphaus, 1992) described above was used to obtain teacher ratings of each student's aggressive behavior. The 14-item Aggression scale (α = .95) included 6 items representing physical aggression from the teacher's perspective. Scores were log-transformed.

A cross-informant composite measure of Physical Aggression frequency was created by subjecting these 13 items (7 PBFS, 6 BASC) to a single-parameter item response theory analysis (Rasch, 1980). Items were eliminated if they did not fit a unidimensional scale or had estimated scale positions redundant with other items. The resultant 9-item composite scale included four BASC (teacher) and five PBFS (student) items, and had Kuder-Richardson reliability > .99 (MVPP, 2009).

Prosocial behavior—Student prosocial behavior was comprised of scores from three BASC subscales and reflect teacher perceptions of the following positive social qualities: (a) Social Skills (e.g., tries to bring out best in others, offers help), (b) Leadership (e.g., usually chosen as leader, good at getting people to work together), and (c) Adaptive Skills (e.g., 'good sport', adjusts well to changes) of students as rated by their teachers (8 items/scale, α = .86 to .91).

Social-Cognitive Problem Solving

The Aggressive Strategies and Competent/Nonviolent Strategies variables were based on an analogue social-cognitive task developed by Hopmeyer and Asher (1997). This measure was selected given its use as the primary social-cognitive problem solving outcome in the large-scale Multisite Violence Prevention Project (2004). Four vignettes describe potential conflict with a same-sex peer, and are highly similar to the vignettes used to measure social-cognitive problem solving in adolescent samples (Dodge et al., 2013) and demonstrate social-cognitive problem solving impairments in middle schoolers with ADHD (Sibley et al., 2010). For each scenario, respondents rated their likelihood on a 5-point Likert scale of using each of six specific strategies and their level of agreement with three statements about their goals in that situation (α^{range} = 0.62 to 0.81)[1]. A similar forced-choice response format has been used in previous ADHD social-cognitive problem solving studies (Maedgen & Carlson, 2000; Melnick & Hinshaw, 1996); limited data suggest similar results when using

forced-choice relative to free-response formats for assessing social-cognitive problem solving (Chung & Asher, 1996; Hopmeyer & Asher, 1997). The Aggressive Strategies and Competent/Nonviolent Strategies composite scales were developed based on a review of the content and intercorrelations among the scales as described below (MVPP, 2008).

Goals and strategies supporting aggression—Aggressive Strategies is comprised of one goal scale (Seeking Revenge, α = .81) and two strategies scales (Mild Physical Aggression [α = .75], and Verbal Aggression [α = 0.77]). These strategy scales were selected based on their significant, positive correlation with the Seeking Revenge goal (r = .509 to .512; all $p < .0005$), and significant negative correlation with the Maintaining a Good Relationship goal and with all competent/nonviolent strategies scales described below (r = −.04 to −.33; all $p < .008$). The resulting factor score, Aggressive Strategies, reflects the extent to which participants endorsed an aggressive problem solving approach characterized by verbal and physical responses intended to seek revenge.

Goals and strategies supporting nonviolent strategies—Competent/Nonviolent Strategies is comprised of one goal scale (Maintaining a Good Relationship, α = .76) and three strategy scales (Compromise [α = .64], Ask a Teacher for Help [α = .78], and Consent/Acquiesce [α = .69]). These strategy scales were selected based on their significant, positive correlation with the Maintaining a Good Relationship goal (r = .31 to .54; all $p < .0005$), and significant negative correlation with the Seeking Revenge goal and all aggressive strategies scales described above (r = −.04 to −.37; all $p < .008$). The resulting factor score, Competent/Nonviolent Strategies, reflects the extent to which participants endorsed a prosocial problem solving approach characterized by strategies intended to resolve the conflict and maintain a positive relationship with the same-sex peer.

Environmental and Comorbidity Influences: Time Invariant Covariates

Three well-established environmental risk factors for aggressive behavior – deviant peer association, school climate, and parental monitoring (MVPP, 2004) – were added as time invariant predictors and allowed to correlate with ADHD status in all models. In addition, the models were tested with and without controlling for oppositional-defiant (ODD) symptoms given disagreement in the literature regarding the extent to which aggressive behavior in ADHD is an artifact of co-occurring oppositional defiant symptoms rather than a core feature of ADHD (Hinshaw & Melnick, 1996). The inclusion of student reported environmental risk factors and teacher reported ODD symptoms as covariates served the additional benefit of reducing the potential impact of mono-informant bias on the primary results (i.e., results reflect associations above and beyond informant response tendencies).

[1]Example vignette: You are going to a performance in the auditorium. You and another [boy/girl] both want to sit in the front row near several of your friends. There is only one chair left in the front row. You get the chair first and sit down. The other [boy/girl] comes up to you and says, “That’s my seat.” *What would you do?* – [5-point Likert scale for each item] – 1. Push him away from the chair (Mild Physical Aggression), 2. Call him a mean name (Verbal Aggression), 3. Tell him I’m sitting here and he can sit in the front row another time (Verbal Assertion), 4. Suggest we each use the chair for half of the performance (Compromise), 5. Let him use the chair (Consent/Acquiesce), 6. Ask a teacher for help (Ask Teacher). *What would be your goal?* -- [5-point Likert scale for each item] – 1. Trying to get along with this student (Maintaining a Good Relationship), 2. Trying not to let him push me around (Maintaining Personal Control), 3. Trying to get back at him for what he just did (Seeking Revenge).

Deviant peer association—The Peer Problem Behavior Scale (Conduct Problems Prevention Research Group, 2000) is a three point scale consisting of 10 items completed at Time 1 that assessed how often the student perceived their peers engaged in deviant behavior in the past 3 months (α = .86; Miller-Johnson et al., 2004).

School climate—School Safety was used as a covariate on all latent intercepts and slopes in the analyses reported below. The scale consisted of 11 items completed at Time 1 that assessed the students' perceptions of the safety in their school, home, and neighborhood (α = .89; Henry, 2000).

Parental monitoring—The parental monitoring scale is part of the larger Parenting Practices Scale (Gorman-Smith et al., 1996) completed at Time 1, a 33-item scale assessing student perceptions of various dimensions of parenting. The Parental Monitoring scale consists of 12 items (α = .74; Miller-Johnson et al., 2004).

Oppositional-defiant symptoms (ODD)—The Conduct Problems subscale from the BASC described above (Time 1 teacher report) was used to control for the association between ADHD and ODD symptoms and mono-informant reporting. Item content reflects oppositional behaviors at school (e.g., disobeys, deceives others, uses others' things without permission) that load separately from the Aggression subscale used in part to derive the primary Aggressive Behavior DV described above (Reynolds & Kamphaus, 1992).

Demographic and Other Potential Influences: Additional Time Invariant Covariates

Ethnicity—Race/ethnicity was entered into all models as a dummy-coded set using the Census Bureau categories listed in Table 1, with Caucasian as the reference group.

GREAT Schools condition—As described above, MVPP condition was controlled in all models using a set of three dichotomous variables to test developmental trends across the middle school years independent of intervention condition: Universal (yes/no), Selective (yes/no), and Combined (yes/no).

Data Analysis

Longitudinal factor scores—Scores on each of the social behavioral and social cognitive variables were standardized longitudinally as *z*-scores to allow unstandardized B-weights to be interpreted as Cohen's *d* effect sizes when predicting from the dichotomous ADHD grouping variable (see *Interpretation of unstandardized B-weights for ADHD effects* below). These longitudinal factor scores were created in Mplus 7.0, wherein initial cross-sectional fit is established and then factor loadings are held constant across time as has been done previously to create an LGM process with latent slope and intercept (Feldt et al., 2000). Measurement model fit was excellent for Aggressive Behavior (Physical Aggression: CFI=0.94, TLI=0.95, RMSEA=.08, SRMR=.049), and acceptable for Prosocial Behavior, Aggressive Strategies, and Prosocial Strategies (all CFI $\geq$ .95, TLI $\geq$ .97, RMSEA $\leq$ .08, SRMR $\leq$ .07).

Latent growth curve modeling (LGM)—LGM was used to examine the interrelations among initial levels (baseline/ intercept; early sixth grade) and age-related changes (slope) in aggressive behavior, prosocial behavior, and social-cognitive problem solving (endorsement of competent/nonviolent goals/strategies, endorsement of aggressive goals/ strategies). Individuals were in the second to third months of sixth grade during initial data collection (2 cohorts of sixth graders; Miller-Johnson et al., 2004; MVPP, 2008, 2009) and were re-evaluated three additional times (end of sixth, seventh, and eighth grades).

The data were analyzed in Mplus Version 7.0 using latent growth models (LGM) with parallel processes and mediating variables (Cheong et al., 2003) and full information maximum likelihood (FIML) estimation (Little & Rubin, 1987). The clustering of school effects were significant (ICCs ≈ .08, very high DEFFs) and were controlled in all models using the TYPE=COMPLEX option which adjusts the standard errors via the sandwich estimator. A robust maximum likelihood (MLR) estimator with the Huber-White covariance adjustment was used, which gives robustness in the presence of any non-normality (Yuan & Bentler, 2000). Additional diagnostics gave credence to the Missing at Random (MAR) assumption, and ADHD status was not related to the probability of missingness ($p > .4$ for all outcomes and mediators). Missing data were handled by the full information maximum likelihood (FIML) approach. FIML uses all available data to estimate parameters and results in unbiased estimates (Little & Rubin, 1987). Thus, 4,424 participants contributed data to at least one study wave (4,137 children provided two waves of data, 3,398 provided 3 waves, and 2,913 were retained across all four study waves). Mediation effects for parallel process LGM were tested using the Sobel (1982) method to compute standard errors of the indirect effects using the methods developed by Cheong et al. (2003). Indirect effects reflect the impact of ADHD on aggressive and/or prosocial behavior through the impact of ADHD on social-cognitive problem solving.

Results

Analysis Overview

Gender, ethnicity, early deviant peer association, school climate, parental monitoring, ODD symptoms, and MVPP violence prevention condition were included in all models reported below (Table 2). Separate models were created for the primary behavioral outcomes of interest. These models are shown in Table 3, Figure 2a (Prosocial Behavior), and Figure 2b (Aggressive Behavior). The Prosocial Behavior (Figure 2a; CFI = 0.993, TLI = 0.987, RMSEA = .012, SRMR = .011) and Aggressive Behavior (Figure 2b; CFI = 0.976, TLI = 0.957, RMSEA = .026, SRMR = .015) models both exhibited excellent model fit. For Prosocial Behavior, the model R^2 was 31% for the latent intercept and 9% for the latent slope. For Aggressive Behavior, the R^2 was 57% for the latent intercept and 36% for the latent slope. Results of the models shown in Figure 2 are presented sequentially: First, we describe the overall impact of social-cognitive problem solving on social behavior across the middle school years (controlling for ADHD and the additional covariates described above). We then describe the direct and indirect impact of ADHD on these social-cognitive and social behavioral outcomes. Between-group differences and age-related changes in each of the primary social-cognitive and social behavioral outcomes are shown in Figure 1.

Impact of Social-Cognitive Problem Solving on Prosocial and Aggressive Behavior

Goals and strategies supporting nonviolent solutions—As shown in Figure 2a, endorsement of Competent/ Nonviolent Goals and Strategies in sixth grade (baseline intercept) predicted Prosocial Behavior in sixth grade (intercept; B = −0.123, p = .02), but not age-related changes in Prosocial Behavior across the middle school years (slope; B = .004, p = .23). In addition, the Competent/Nonviolent slope was not related significantly to the Prosocial Behavior slope (B = 0.014, p = .80). As shown in Figure 2b, the Nonviolent intercept was not related significantly to the Aggressive Behavior intercept (B = −0.028, p = .06) or slope (B = 0.002, p = 0.14). Similarly, the Nonviolent Strategies slope did not predict the Aggressive Behavior slope (B = −0.035, p = 0.29). Collectively, this suggests a relation between competent/nonviolent goals/strategies and prosocial but not aggressive behavior in sixth grade; however, neither baseline nor age-related changes in nonviolent problem solving predicted age-related changes in prosocial or aggressive behavior, suggesting minimal influence of nonviolent social-cognitive problem solving on changes in social behavior across the middle school years.

Goals and strategies supporting aggression—As shown in Figure 2a, the Aggressive Strategies intercept was related significantly to the Prosocial Behavior intercept (B = -.223, p < .0005) but not the Prosocial Behavior slope (B = −0.003, p = .33). The Aggressive Strategies slope significantly predicted the Prosocial Behavior slope (B = -.139, p < .0005). As shown in Figure 2b, the Aggressive Strategies intercept significantly predicted the intercept (B = .132, p < .0005) and slope (B = .006, p < .0005) of Aggressive Behavior. In addition, the Aggressive Strategies slope predicted the Aggressive Behavior slope (B = .243, p < .0005). Collectively, these results indicate that aggressive social-cognitive problem solving predicts overt prosocial and aggressive behaviors. Sixth grade children who endorse more aggressive solutions to problems are viewed as engaging concurrently in more aggressive behavior and fewer prosocial behaviors relative to sixth graders who endorse fewer aggressive solutions. In addition, age-related increases in aggressive strategy endorsement are associated with concurrent age-related increases in aggressive behavior and decreases in prosocial behavior. Importantly, early aggressive strategy endorsement in sixth grade portends an increased risk for additional age-related increases in aggressive behavior, even after accounting for the risk portended by early aggressive behavior and other confounding influences.

ADHD Status: Between-Group Differences in Social Behavior and Social-Cognitive Problem Solving

Interpretation of unstandardized B-weights for ADHD effects—Because all primary social behavioral and social-cognitive problem solving variables were standardized longitudinally when creating the latent factors (see *Data Analysis*), unstandardized regression path coefficients (B-weights) can be interpreted as Cohen's *d* effect sizes when predicting from a dichotomous variable (elevated ADHD symptoms = 0, 1; Hayes, 2009). Thus, B-weights for pathways in which ADHD predicts the intercept of social-cognitive problem solving, aggression, and prosocial behavior reflect the magnitude of between-group differences in standard deviation units (Hayes, 2009). B-weights for ADHD predicting slope are interpreted as effect size per month (Duncan et al., 2006).

Prosocial and aggressive behavior—As shown in Figure 2a, ADHD predicted the intercept (B = −0.438, $p < .0005$) and slope (B = 0.019, $p = .03$) of Prosocial Behavior. As shown in Figure 2b, ADHD also predicted the intercept (B = 0.196, $p < .0005$) and the slope (B = −0.009, $p = .003$) of Aggressive Behavior. This pattern of results indicates that sixth grade children with clinically elevated ADHD symptoms evince somewhat more aggressive ($d = 0.20$) and somewhat fewer prosocial behaviors ($d = −0.44$) relative to their peers, even after accounting for ODD symptoms, deviant peer association, school climate, parental monitoring, gender, and ethnicity. Inspection of the ADHD-to-slope pathways indicates that between-group differences in prosocial behavior (Figure 2a) and aggressive behavior (Figure 2b) decrease in magnitude across the middle school years. The decrease in prosocial behavior magnitude is attributable to significant improvements in prosocial behavior for the ADHD (slope $p < .0005$) but not non-ADHD group (slope $p > .10$). In contrast, the decreasing magnitude of between-group differences in aggressive behavior across the middle school years is attributable to a concurrent decreases for the ADHD group ($p = .003$) and increases for the non-ADHD group ($p < .0001$). Comparison of the effect sizes for the impact of ADHD symptoms on intercept and slope for prosocial behavior (intercept $d = −0.44$ vs. slope $\Delta d = 0.63$) and aggressive behavior (intercept $d = 0.20$ vs. slope $\Delta d = −0.30$) suggests that the modest social impairments evinced by sixth graders with clinically elevated ADHD symptoms decrease but are not normalized by the end of middle school (Figure 1) [2].

Social-cognitive problem solving—The direct impact of ADHD on the social-cognitive variables was highly similar across the Prosocial Behavior (Fig. 2a) and Aggressive Behavior (Fig. 2b) models. With ODD Symptoms in the model, the ADHD-to-intercept pathways for Aggressive Strategies (B = 0.050, $p = .52$) and Competent/Nonviolent Strategies (B = −0.068, $p = .34$) were nonsignificant, as were both ADHD-slope pathways (both $p > .39$).

ADHD Indirect Effects (Mediation Analyses)

All indirect effects of ADHD on social behavior through social-cognitive problem solving were nonsignificant based on the Sobel (1982) test (all $p > .10$). Combined with the findings above, these results suggest that both ADHD and social-cognitive problem solving contribute independently to social behavioral difficulties in middle school, but that the developmental trajectory of social-cognitive problem solving is highly similar for emerging adolescents with and without clinically elevated ADHD symptoms (Figure 1, right column).

Sensitivity analyses

A final set of analyses probed the extent to which specific methodological choices impacted the obtained pattern of results. First, we relaxed the ADHD inclusion criteria from 2 SD to 1.5 SD to test the extent to which the ADHD group's improved (but not normalized) social behavior across the middle school years was attributable to our extreme group categorization. Significance and magnitude of all pathways failed to show the decrease

[2]Slope effect sizes reflect the unstandardized B-weight (interpreted as Cohen's d effect size change per month – see *Interpretation of unstandardized B-weights for ADHD effects* above) multiplied by the 33 months of middle school assessed in the current study: For example, Prosocial Behavior latent slope $d = 0.019/\text{month} \times 33 \text{ months} = 0.63$.

expected if results were attributable to regression to the mean; interpretation of the results was unchanged when relaxing the ADHD inclusion criteria. We then further probed this conclusion using a continuous rather than dimensional ADHD variable (mean Attention Problems and Hyperactivity T-score). The significance, direction, and interpretation of all ADHD-to- slope pathways remained unchanged. All ADHD-to-intercept pathways were similarly unchanged with the exception that very small but significant magnitude associations between ADHD Symptoms and the Nonviolent Strategies intercept (B = −0.004, $p < .05$) and Aggressive Strategies intercept (B = 0.007, $p < .05$) emerged. Combined with the findings that relative improvements were (a) selectively found for social behavior but not social cognitive outcomes, (b) replicated using dimensional ratings, and (c) not solely attributable to changes in the ADHD group, it appears unlikely that the results are fully attributable to statistical artifacts such as regression to the mean.

Next, we probed the effectiveness of our control for MVPP intervention effects. Examination of the Selective and Combined school samples revealed that 415 (37 ADHD, 147 non-ADHD) of the 4,593 children (4.0%) were direct beneficiaries of the selective family intervention. The significance and magnitude of all pathways was highly similar when excluding these children. Finally, all models were run with and without ODD symptoms as a covariate given disagreement in the literature regarding the extent to which aggressive behavior in ADHD is an artifact of co-occurring ODD symptoms rather than a core feature of ADHD (Hinshaw & Melnick, 1996). As expected, larger effect sizes were obtained for all ADHD-intercept and most but not all ADHD-slope pathways[3]. Importantly, longitudinal patterns of ‘improvements’ in social behavior associated with the ADHD Symptoms group remained significant, if somewhat stronger, when failing to control for ODD comorbidity.

Discussion

The current study examined the longitudinal association between social-cognitive problem solving and aggressive and prosocial behavior in a large sample of students across the middle school years, and whether these relations differed for emerging adolescents with clinically elevated ADHD symptoms. Of primary interest was the extent to which ADHD conveyed increased risk for more aggressive and fewer prosocial behaviors, and the extent to which these relations were mediated by ADHD children’s expected social-cognitive problem solving difficulties. Overall, sixth graders with clinically elevated ADHD symptoms were perceived as engaging in moderately fewer prosocial behaviors ($d = −0.44$) and mildly increased aggressive behavior ($d = 0.20$) relative to sixth graders without ADHD, even after accounting for the risk portended by ODD symptoms, deviant peer association, school climate, parental monitoring, gender, ethnicity, and the potential impact of a school-wide violence prevention program. Further, the association between ADHD status and social behavioral problems was significantly stronger prior to accounting for ODD symptoms ($d = −1.2$ vs. −0.49, respectively), highlighting the importance of controlling for comorbidity

[3]ADHD-to-Intercepts: Aggressive Behavior ($d = 0.20$ vs. 1.39), Prosocial Behavior: ($d = −0.44$ vs. −1.04), Aggressive Strategies ($d = 0.05$ vs. 0.31), Competent/Nonviolent Strategies ($d = −0.07$ vs. −0.14). ADHD-to-Slopes: Aggressive Behavior ($d = −0.30$ vs. −1.98), Prosocial Behavior ($d = 0.63$ vs. 0.89). ODD minimally affected the relationship between ADHD and social-cognitive trajectories (both remained nonsignificant; $p > .05$).

when examining social behavioral functioning in ADHD. Thus, the current results appear congruent with prevailing views that aggressive behavior in ADHD is attributable primarily – but not exclusively – to co-occurring ODD symptoms, as well as studies of clinically diagnosed ADHD samples documenting social behavioral problems after accounting for ODD (Bagwell et al., 2001; Clark et al., 2002). In addition, this finding is broadly consistent with studies documenting ADHD-related social behavioral difficulties with aggressive behavior (Bacchini et al., 2008; Holmberg & Hjern, 2008; Unnever & Cornell, 2003; Zalecki & Hinshaw, 2004) and prosocial skills (Erhardt & Hinshaw, 1994; Kofler et al., 2011), as well as longitudinal data demonstrating an adverse impact of middle school on ADHD symptom trajectories (Langberg et al., 2008).

Importantly, the modest social behavioral difficulties evinced by emerging adolescents with clinically elevated ADHD symptoms decreased significantly across the middle school years, and were characterized by improved but not normalized prosocial and (decreased) aggressive behavior relative to their non-ADHD peers. Although regression to the mean cannot be ruled out conclusively, the current findings provide a somewhat optimistic perspective regarding long-term social outcomes beyond the elementary school years, in part by suggesting that poor social outcomes may be attributable in part to factors other than ADHD per se. That is, sixth graders with clinically elevated ADHD symptoms showed moderate gains in their relative social-behavioral standing across the middle school years due to their increasing prosocial behavior and decreasing aggressive behavior despite the non-ADHD group's normative increases in aggressive behavior (Bongers et al., 2003). However, small magnitude impairments in positive and negative social behavior remained after accounting for ODD symptoms and other potential confounding influences, underscoring the unique role of ADHD in social development during the critical middle school years. In addition, most previous studies documenting increased aggressive behavior (e.g., bullying) in children with ADHD have also found that these children are more likely to themselves be bullied or victims of aggressive behavior (cf. Unnever & Cornell, 2003), suggesting that future studies are needed to disentangle the extent to which this aggressive behavior reflects instrumental as opposed to reactive social behaviors.

The current findings provide new data suggesting that the magnitude of prosocial and aggressive behavioral difficulties reaches its maximum by sixth grade (or earlier) among emerging adolescents with clinically elevated ADHD symptoms, and becomes somewhat more similar to that of non-ADHD children across the middle school years (Figure 1). Interestingly, this finding was obtained for both prosocial and aggressive behavior, but for different reasons. That is, the ADHD group moved toward the non-ADHD group with regards to prosocial behavior, whereas the non-ADHD and ADHD groups moved toward each other with regards to aggressive behavior. Inspection of effect sizes for the impact of ADHD status on the social behavioral intercepts and slopes suggests that this developmental process improves but does not normalize their relative standing by the end of eighth grade. One possible explanation for these findings is that middle schoolers with clinically elevated ADHD symptoms responded differentially to the violence prevention programs that occurred in study year 1; however, the MVPP programs minimally impacted social cognitive functioning (MVPP, 2008) and were controlled for in all analyses. In addition, the results were highly similar when students directly receiving the selective family MVPP intervention

were excluded, and meta-analytic data indicate that cognitive interventions are generally ineffective for children with ADHD (Abikoff, 1991; Washington State Institute for Public Policy, 2012). Thus, the most parsimonious conclusion appears to be that the interpersonal impairments of students with clinically elevated ADHD symptoms remain significant but may be less apparent by the end of middle school than they were in sixth grade (i.e., the small magnitude impairments become even smaller across the middle school years). It is important for future investigations to characterize factors that may underlie this trajectory (e.g., cortical maturation and related neurocognitive processes; Shaw et al., 2007).

The current pattern of prosocial behavior decrements across the middle school years is inconsistent with reports from observational studies suggesting that elementary-aged children with ADHD engage in similar levels of prosocial behavior relative to their peers (Erhardt & Hinshaw et al., 1994; Huang-Pollock et al., 2009). This discrepancy may be related to our large sample size and use of longitudinally derived latent factors comprised of multiple indicators of functioning across time. This method results in increased power for detecting effects due to the removal of multiple sources of error (cf. Shipstead et al., 2012), and thus allows for more precise evaluation of the relation between ADHD status and global, prosocial functioning. A second possible explanation concerns methodological differences across studies, in particular the use of global ratings (current study) relative to observational data (Erhardt & Hinshaw, 1994) or an analogue social interaction task (Huang-Pollock et al., 2009). Observational and analogue tasks are generally recognized as providing more objective, molecular data regarding children's ability to demonstrate target behaviors in novel settings (Harris & Lahey, 1982), whereas global teacher-report measures may provide more ecologically valid indicators of overall classroom social functioning (Barkley, 1991). This distinction is particularly important given the relative stability of peer interactional patterns in classroom settings (Stormshak et al., 1999), and suggests that the improved sensitivity of standardized rating scales for detecting impaired prosocial behavior may be related to their ability to capture peer interactional patterns over time. This hypothesis is consistent with studies simultaneously documenting nonsignificant ADHD/non-ADHD group differences on objective measures of prosocial behavior and significant ADHD/non-ADHD prosocial impairments as reported by parents and teachers (e.g., Huang-Pollock et al., 2009).

The Role of Social-Cognitive Problem Solving in Overt Aggressive and Prosocial Behavior

For emerging adolescents, early social-cognitive problem solving biases toward aggression predicted increased levels of physically aggressive behavior, and decreased levels of prosocial behavior, both initially and across the middle school years. In addition, these early social-cognitive biases were associated with steeper age-related increases in aggressive behavior, beyond the risk portended by ADHD status, early aggressive behavior, deviant peer association, school climate, parental monitoring, gender, and ethnicity. This pattern of results is consistent with developmental research implicating social-cognitive processes in adverse interpersonal outcomes (Dodge et al., 2013; Ladd & Mize, 1983; Melnick & Hinshaw, 1996; Selman et al., 1986). That is, middle schoolers whose social-cognitive problem solving results in a bias toward aggression are more likely to behave in ways consistent with this bias (i.e., more aggressive and fewer prosocial behaviors; Melnick &

Hinshaw, 1996). In contrast, social-cognitive processes associated with endorsing competent/nonviolent strategies generally failed to predict developmental changes in aggressive and prosocial behavior across the middle school years, and our models predicted age-related changes in physical aggression (R^2 = .36) significantly better than changes in prosocial behavior (R^2 = .09). This pattern of findings was contrary to our hypotheses, and may help account for the modest impact of violence prevention programs that train nonviolent social-cognitive problem solving strategies as a primary intervention target (CPRRG, 1999; MACSRG, 2002; MVPP, 2008, 2009).

Of particular interest in the current study was the extent to which the social behavioral problems exhibited by middle schoolers with ADHD were attributable to biased social-cognitive problem solving strategies. Overall, ADHD and social-cognitive problem solving independently predicted social behavior across the middle school years. In addition, the ADHD and non-ADHD groups both displayed similar age-related changes in social-cognitive problem solving (Figure 1), suggesting no evidence of delayed or deviant social-cognitive development across the middle school years. Interestingly, no association between ADHD and social-cognitive problem solving was observed when ODD symptoms were included in the model. This pattern of results was consistent with the general trend found in the ADHD literature, wherein smaller effects are typically reported for studies controlling for ODD status (d = 0.01 to 0.37; Marton et al., 2009; Melnick & Hinshaw, 1996) relative to studies that did not control for this common co-morbidity (d = 0.24 to 0.91; Maedgen & Carlson, 2000; Sibley et al., 2010; Zentall et al., 2001). Although several methodological factors may account for these between-study differences, the current findings suggest that social-cognitive problem solving biases may be associated with increased risk for ODD symptoms rather than ADHD symptoms per se; however, the directionality of this association warrants scrutiny.

Given the lack of between-group differences in social-cognitive problem solving, it is not surprising that aggressive and competent/nonviolent problem solving strategies independently predicted social behavior but failed to explain the difficulties displayed by the ADHD Symptoms group. This pattern of results – that emerging adolescents with clinically elevated ADHD symptoms have difficulties with social behavior but not social-cognitive problem solving – is consistent with recent conceptualizations of social problems in ADHD as a performance rather than acquisition/skills deficit. In other words, children with ADHD appear to have intact social knowledge and social problem solving abilities, and possess age-appropriate social skills, but have difficulty applying these skills consistently (cf. de Boo & Prins, 2007). This hypothesized disconnect between social knowledge/problem solving and social behavior in ADHD is consistent with the current study's non-significant mediation effects, and suggests that alternative social-cognitive assessments (e.g., *in situ* observations), sub-processes involved in social-cognitive problems solving (encoding/retrieval of social rules; Dodge et al., 2013), and/or factors beyond social-cognitive problem solving are needed to explain ADHD-related social difficulties.

Consistent with extant literature (Bagwell et al., 2001; Friedman et al., 2003), ADHD status was correlated with ODD symptoms (r = .49) and modestly associated with self-reported deviant peer association (r = .10), decreased parental monitoring (r = -.07), and increased

school safety problems (r = .04). Additional factors known to be associated with ADHD, such as impaired executive functioning (Kasper, Alderson, & Hudec, 2012; Willcutt et al., 2005), academic outcomes (Frazier, Youngstrom, Glutting, & Watkins, 2007; Sarver et al., 2012), and behavioral symptoms (Andrade et al., 2009; Diamantopoulou et al., 2007; Kofler et al., 2011; Stormshak et al., 1999) may provide improved incremental prediction of interpersonal functioning in middle schoolers with ADHD. For example, Kofler and colleagues (2011) found that working memory abilities and ADHD behavioral symptoms (inattention, hyperactivity/impulsivity) strongly predict ADHD-related social problems, such that impaired social interactions reflected, to a significant extent, the behavioral outcomes of working memory deficits. Similarly, Huang-Pollock and colleagues (2009) reported that executive functioning abilities (behavioral inhibition, short-term verbal memory, and planning) in children with ADHD significantly mediated parent- and teacher-rated social problems, as well as their ability to detect subtle verbal cues during an analogue social interaction task. In contrast, these executive functions did not predict the number of prosocial or hostile statements made during the same task (Huang-Pollock et al., 2009) and ADHD subgroups defined based on impairments in short-term memory, planning, and attention may not differ with regards to social impairments (Biederman et al., 2004). In addition, children who exhibit academic difficulties – an outcome commonly reported in ADHD (Frazier et al., 2007) – are also more likely to have peer relational difficulties (Erhardt & Hinshaw, 1994). Future studies investigating the longitudinal association among these factors are needed to further clarify the mechanisms and processes responsible for ADHD-related social behavioral difficulties, in anticipation of developing novel intervention programs aimed at improving interpersonal functioning.

Limitations

The current study employed a large, multi-site, and multi-cohort sample of boys and girls with and without clinically elevated ADHD symptoms across four study waves spanning the middle school years. The following limitations must be considered when interpreting the present results, however, despite these and other methodological refinements (e.g., use of LGM mediation; control for measurement error, cohort effects, and nesting effects). First, the ADHD grouping variable was based exclusively on teacher reports of ADHD-Combined symptoms, which while highly predictive of a clinical diagnosis of ADHD (Vaughn & Hoza, 2013), may not correspond completely with clinical designation based on diagnostic interview or more thorough multi-method determinations given the limited interactions middle school teachers may have with their students (Evans et al., 2005; Sibley et al., 2012). However, the percentage of emerging adolescents identified as ADHD Combined Presentation in the current study (3.5%) is highly consistent with expected prevalence rates across subtypes/presentations (3% to 5%; APA, 2013), and findings regarding the relations among ADHD status, social-cognitive problem solving, and social behavior were consistent with data from clinically diagnosed samples (Bagwell et al., 2001; Marton et al., 2009). Nonetheless, we refer to the current sample in terms of ‘clinically elevated ADHD symptoms’ to acknowledge this limitation, and argue that our results call strongly for large, longitudinal studies of clinically diagnosed children and adolescents with ADHD to foster our understanding of developmental trajectories in interpersonal and other key areas of functioning.

A second limitation of the current study was the reliance on analogue social-cognitive tasks (vignettes) with Likert/forced-choice responding, as well as the use of teacher- and student-report measures of social behavioral functioning. Despite the prospective design employed in the current study, extant evidence suggests that recognition tasks generally show smaller effects relative to free/cued recall tasks in ADHD studies (Rapport et al., 2000), and these methods may be subject to internal validity threats such as recall bias, as well as positive and negative halo, positive illusory bias (Hoza et al., 2012), expectancy, and shared method/informant effects (Harris & Lahey, 1982; Shipstead et al., 2012). In addition, the social-cognitive outcomes focused on strategies and goals for solving hypothetical peer conflicts and not their application to actual problem situations. This limitation was largely driven by the availability of suitable measures that could be employed within the scope and available budget of this large-scale study, but will be important to consider for future studies given evidence that children with ADHD may be poor reporters of their social functioning (Hoza, 2007) and recent conceptualizations of ADHD as associated with social performance but not necessarily social skill deficits (de Boo & Prins, 2007). Future studies investigating prosocial behaviors in children and adolescents with ADHD may benefit from more objective measures such as direct observation (Erhardt & Hinshaw, 1994) and carefully controlled social interaction tasks (Huang-Pollock et al., 2009). This broader and more fine grained assessment of social-cognitive problem solving is needed to determine the extent to which the lack of association found in the current study is attributable to methodological factors or failure to assess specific subprocesses involved in prosocial and aggressive strategy generation (e.g., social comprehension, social perspective taking, subtle verbal cue detection; Andrade et al., 2012; Lorch et al., 2000; Marton et al., 2009).

Third, we were unable to control for socioeconomic status, substance use, or victimization problems in the current sample. We were, however, able to control for established correlates of these risk factors, including deviant peer association, parental monitoring, school climate, gender, and ethnicity. Fourth, although over 94% of the sample was retained across at least 2 data points, attrition was moderately high for the seventh and eighth grade assessments (77% and 66% retention, respectively). Finally, it is likely that some middle schoolers in the ADHD group were receiving pharmacological and/or behavioral treatment during the course of the study. Meta-analytic results, however, suggest that the impact of concurrent prevention and intervention efforts likely had a modest impact on the current findings: None of our currently available, evidence-based treatments result in significant improvements in social-cognitive functioning in ADHD (Abikoff, 1991; Washington State Institute for Public Policy, 2012), whereas social behavior may be improved but not normalized by extant pharmacological and psychosocial interventions (van der Oord et al., 2008). While these findings suggest that the current results are robust, they speak clearly to the need for novel intervention programs targeting interpersonal functioning for youth with ADHD (Mikami et al., 2010).

Clinical and research implications

Results of the current study provide additional evidence that clinically elevated ADHD symptoms represent a moderate yet significant risk factor for social behavioral difficulties throughout the middle school years, above the risk conveyed by social-cognitive problem

solving tendencies, deviant peer association, school climate, parental monitoring, ODD symptoms, gender, and ethnicity. The social behavioral difficulties observed were small in magnitude for sixth graders in the ADHD group, and decreased further but were not normalized across the middle school years. Importantly, social-cognitive processes associated with competent/nonviolent strategy endorsement were longitudinally unrelated to social behavioral outcomes, despite the ability to detect very small magnitude effects. This finding was surprising given that these processes are frequent targets of violence prevention programs and often assumed to reflect a key mechanism underlying social behavioral change (Boxer & Dubow, 2002; MVPP, 2009; USDHHS, 2001; Wilson et al. 2003). If replicated across a broader sampling of social-cognitive problem solving metrics, these findings suggest that social skills interventions and violence prevention programs may need to be modified to focus less on increasing nonviolent solutions to conflicts and more on decreasing endorsement of aggressive solutions, and highlight the need to examine alternative strategies and interventions that may impact youth's social-cognitive problem solving abilities and social behavior.

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General Scientific Summary

Childhood ADHD is associated with social behavioral difficulties, but less is known about positive (prosocial) behavior, or how their social behavior changes beyond the elementary years. This study found that ADHD status and social-cognitive problem solving contributed independently to social behavior, both in sixth grade and across the middle school years; the influence of social-cognitive problem solving on social behavior was highly similar for the ADHD and non-ADHD groups.

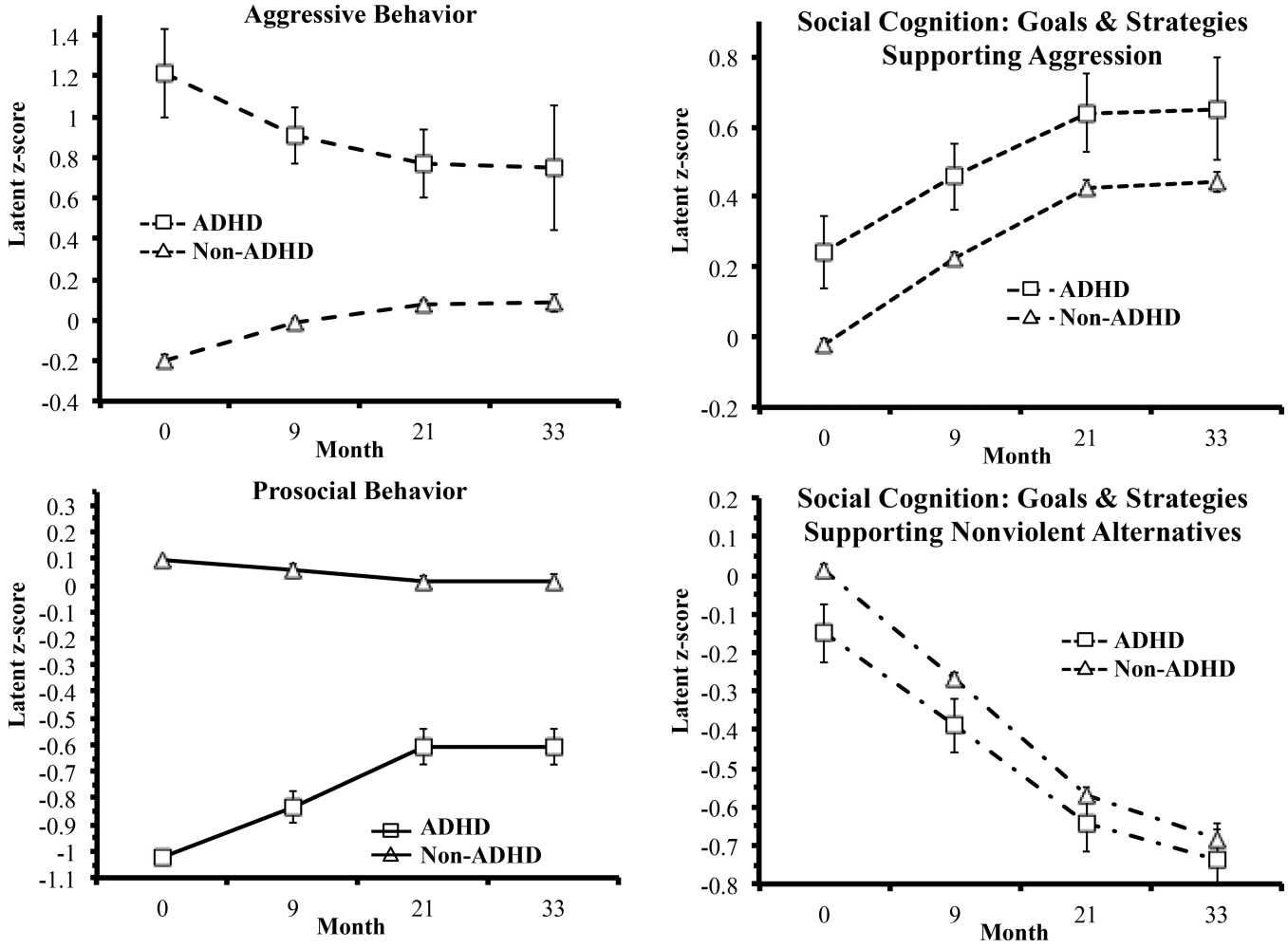

Figure 1.

Slope trajectories of the mediators and outcomes of interest across the 33 months of assessment. Time points reflect months since the beginning of sixth grade (Time 0): end of sixth grade (month 9), end of seventh grade (month 21), and end of eighth grade (month 33). Squares reflect middle schoolers with clinically elevated ADHD symptoms (ADHD group); triangles reflect comparison middle schoolers (non- ADHD group). Point estimates reflect marginal means from the unconditional model with full information maximum likelihood (FIML) estimation accounting for missing data. Error bars reflect bias-corrected, bootstrapped 95% confidence intervals.

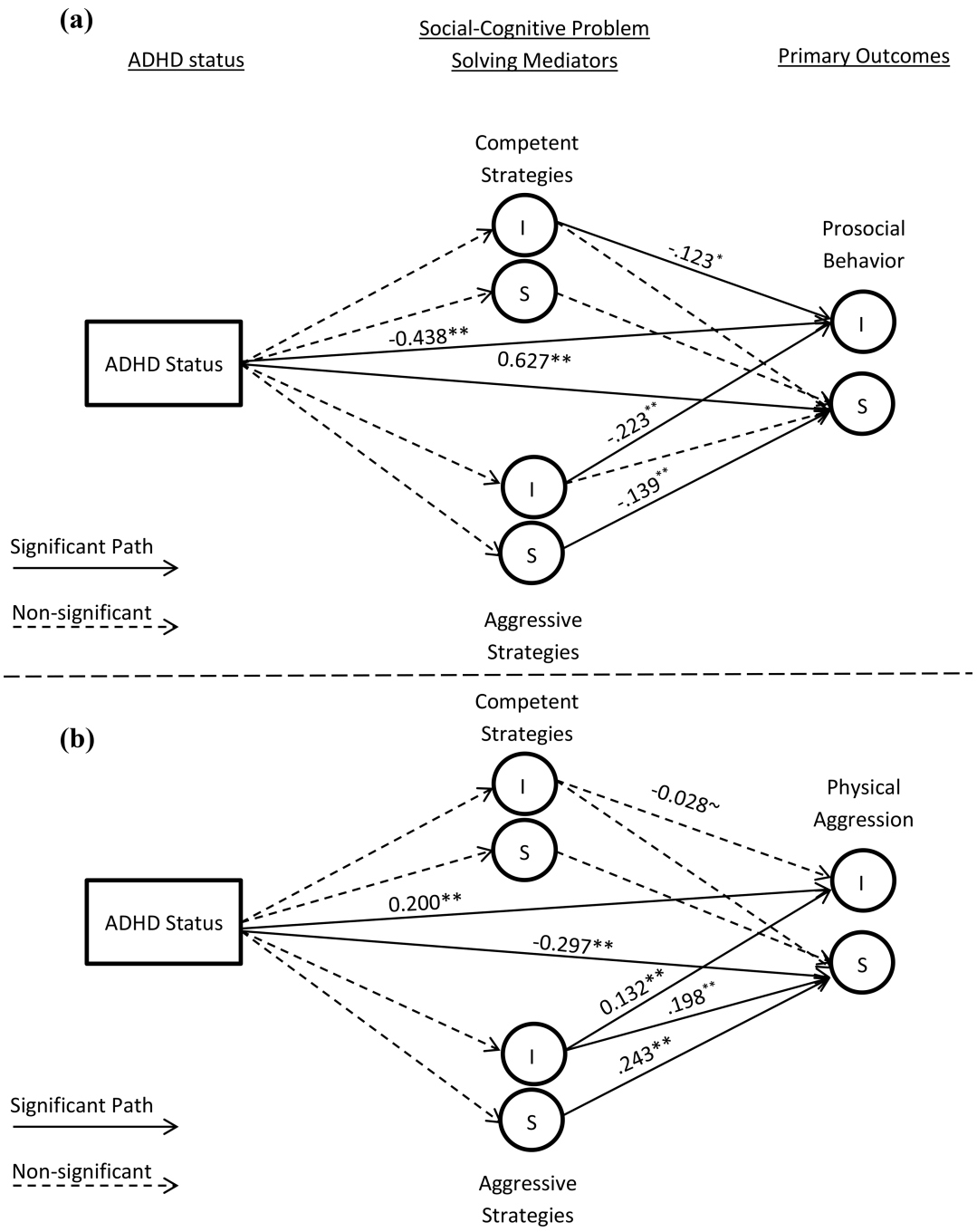

Figure 2.

Parallel process latent growth curve mediation models of the impact of ADHD status on social-cognitive problem solving and (a) Prosocial Behavior, and (b) Aggressive Behavior. All covariates (ethnicity, gender, intervention, ODD problems, peer deviancy, school safety problems, parental monitoring) were regressed on all latent LGM slope and intercept variables, and were allowed to correlate with ADHD status (Table 3; not shown in Figures). ADHD to slope and Intercept to slope pathway estimates reflect the total change over

middle schools (B-weight*33 months). I=Intercept, S=Slope. ~, $p < .10$; *, $p < .05$; **, $p < .01$

Table 1

Sample demographics.

Sample	N	Percent
ADHD Status		
Suspected ADHD students	178	3.5%
Non-ADHD students	3806	74.0%
Excluded students	1158	22.5%
Gender		
Male	2752	49.2%
Female	2843	50.8%
Ethnicity		
Hispanic	1142	20.4%
Black	3018	53.9%
Native American	321	5.7%
Indian	87	1.6%
Asian	83	1.5%
Caucasian	1050	18.8%
School-wide Prevention Program Status		
Universal	1440	25.7%
Selective	1494	26.7%
Combined	1335	23.9%
Control	1326	23.7%

Table 2

Intercorrelations among latent variable intercepts (I) and slopes (S), ADHD status, and time invariant covariates

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Aggressive Strategies (I)	1.00*														
2. Aggressive Strategies (S)	−.20**	1.00**													
3. Nonviolent Strategies (I)	−.73**	0.05**	1.00**												
4. Nonviolent Strategies (S)	0.17**	−.77**	−.19**	1.00**											
5. Prosocial Behaviors (I)	−.36**	0.05**	0.19**	−.01**	1.00**										
6. Prosocial Behaviors (S)	0.03**	−.15**	0.08**	0.07**	−.70**	1.00**									
7. Aggressive Behaviors (I)	0.47**	−.08**	−.34**	0.06**	−.41**	0.19**	1.00**								
8. Aggressive Behaviors (S)	−.01**	0.29**	−.02**	−.23**	−.13**	−.20**	−.72**	1.00							
9. ADHD Status	0.17**	−.06**	−.10**	0.03**	−.30**	0.21**	0.32**	−.16**	1.00						
10. ODD Problems	0.29**	−0.02**	−.19**	0.08**	−.49**	0.26**	0.56**	−.24**	0.49**	1.00					
11. Gender (Male)	0.14**	0.14**	−.23**	−.10**	−.24**	−.08**	0.18**	−.05**	0.10**	0.15**	1.00				
12. Minority Status	0.20**	0.06**	−.02**	−.08**	−.22**	0.06**	0.16**	0.05**	0.07**	0.14**	−.03**	1.00			
13. Peer Deviancy	0.45**	−.15**	−.29**	−.15**	−.20**	−.01**	0.32**	−.03	0.10**	0.17**	0.06**	0.13**	1.00		
14. School Safety Problems	0.11**	0.08**	0.07**	0.08**	−.19**	0.01**	0.10**	0.02	0.04**	0.10**	0.04**	0.23**	0.10**	1.00*	
15. Parental Monitoring	−.31**	0.12**	0.26**	0.12**	0.21**	0.02**	−.19**	0.01	−.07**	−.10**	−.09**	−.07**	−.20**	−.13**	1.00**
16. Universal Condition	0.04**	0.04**	−.01**	−.04**	−.05**	0.03**	0.05**	0.04**	0.04**	0.03*	0.03**	0.05**	0.02	0.02**	0.02**
17. Selective Condition	−.01**	−.03**	0.01**	0.03**	0.05**	−.06**	−.01**	−.05**	−.00**	−.06**	−.00**	−.00**	0.00	−.03**	−.05**
18. Combined Condition	0.00**	−.01**	0.02**	−.01**	−.05**	0.06**	0.00**	0.01	−.01**	0.00	−.02**	0.01**	0.03**	0.06**	0.02**

* $p < .05$;

** $p < .01$

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Table 3

B-weights and standard errors of time invariant covariates on mediators and outcomes.

Variable	Outcomes															
	Competent/Nonviolent Strategies				Aggressive Strategies				Aggressive Behaviors				Prosocial Behavior			
	Latent Intercept		Latent Slope		Latent Intercept		Latent Slope		Latent Intercept		Latent Slope		Latent Intercept		Latent Slope	
	B	(SE)	B	(SE)	B	(SE)	B	(SE)	B	(SE)	B	(SE)	B	(SE)	B	(SE)
Universal Condition	0.056	0.051	−0.011	0.044	−0.011	0.044	0.006*	0.003	0.030*	0.014	−0.001	0.001	−0.079	0.086	0.005	0.004
Selective Condition	0.039	0.047	−0.005	0.044	−0.005	0.044	0.000	0.003	0.033**	0.012	−0.003*	0.001	−0.007	0.099	−0.001	0.006
Combined Condition	0.057	0.051	−0.016	0.038	−0.016	0.038	0.001	0.002	0.017	0.011	−0.001	0.001	−-0.111	0.082	0.006	0.004
Peer Deviancy [a]	−0.329**	0.045	0.004	0.003	0.572**	0.047	−0.010**	0.004	0.119**	0.012	−0.001	0.001	−0.073	0.036	−0.003	0.002
School Safety Issues [a]	0.072**	0.016	−0.002*	0.001	0.008	0.016	0.002**	0.001	0.008	0.004	0.000	0.000	−0.113**	0.019	−0.001	0.001
Parental Monitoring [a]	0.122**	0.014	−0.004**	0.001	−0.129**	0.015	0.003**	0.001	−0.014**	0.004	−0.001	0.000	0.112**	0.015	0.001	0.001
Male	−0.188**	0.028	−0.094**	0.031	0.092**	0.028	0.009**	0.002	0.033**	0.007	−0.002*	0.001	−0.223**	0.040	−0.008*	0.002
ADHD Status	−0.068	0.071	0.027	0.051	0.050	0.078	−0.006	0.008	0.196**	0.032	−0.009**	0.003	−0.438**	0.090	0.019**	0.005
ODD	−0.003	0.002	0.019	0.045	0.010**	0.002	0.000	0.000	0.012**	0.001	0.000**	0.000	−0.032**	0.003	0.001**	0.000
Hispanic	0.144**	0.045	−0.003	0.003	0.098**	0.033	0.005~	0.003	0.001	0.011	−0.003**	0.001	−0.035	0.059	0.005	0.004
Black	−0.041	0.030	−0.005	0.002	0.186**	0.028	0.003	0.002	0.051**	0.007	0.002**	0.001	−0.317**	0.043	0.001	0.003
Native American	0.017	0.047	−0.004	0.004	0.017	0.045	0.006	0.004	0.023	0.015	−0.001	0.001	−0.051	0.057	−0.002	0.004
Indian	0.051	0.098	−0.001	0.006	−0.052	0.104	−0.006	0.004	−0.063*	0.025	0.005	0.003	−0.068	0.103	0.006	0.007
Asian	0.121	0.086	0.002	0.007	0.054	0.105	−0.007	0.008	−0.031	0.023	0.001	0.000	0.269*	0.107	0.001	0.006

*p, <.05;

**p < .01;

[a] Student self-report rating