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Children's ADHD Symptoms and Friendship Patterns across a School Year

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Abstract
Symptoms of attention-deficit/hyperactivity disorder (ADHD) in elementary school-age children are associated with poor relationships with classroom peers, as indicated by poor social preference, low peer support, and peer victimization. Less is known about how friendship patterns relate to ADHD symptoms, or how friendships may buffer risk for negative peer experiences. Participants were 558 children in 34 classrooms (grades K-5). At the beginning (fall) and end (spring) of an academic year, children completed (a) sociometric interviews to index friendship patterns and social preference, and (b) self-report questionnaires about their support and victimization experiences from classmates. In fall, higher teacher-reported ADHD symptoms were associated with children having more classmates with no friendship ties (non-friends) and who the child nominated but did not receive a nomination in return (unreciprocated friends), and with having fewer classmates with mutual friendship ties (reciprocated friends) and who nominated the child but the child did not nominate in return (unchosen friends). Higher fall ADHD symptoms predicted more non-friend classmates, poorer social preference, and more victimization in the spring, after accounting for the same variables in fall. However, having many reciprocated friends (and to a lesser extent, many unchosen friends) in fall buffered against the trajectory between fall ADHD symptoms and poor peer functioning in spring. By contrast, having many unreciprocated friends in fall exacerbated the trajectory between fall ADHD symptoms and poor peer functioning in spring. Thus, elevated ADHD symptoms are associated with poorer friendship patterns, but reciprocated friendship may protect against negative classroom peer experiences over time.

Keywords ADHD · Friendship · Peer relationships · Social preference

Elevated attention-deficit/hyperactivity disorder (ADHD) symptoms put children at risk for peer relationship difficulties in their classroom, as indicated by poor social preference, low peer support, and more victimization experiences (for review, see Gardner & Gerdes, 2015). Researchers have drawn attention to dyadic friendship as a distinct construct from acceptance by the peer group at large (Marton et al., 2015; Mikami, 2010); however, friendship has received less attention in the ADHD literature compared to other aspects of peer functioning. Given the unique contribution of friendship to adjustment (Bagwell et al., 2001; Parker & Asher, 1993), it is important to understand how friendships are impacted by the symptoms of ADHD, as well as any potential protective effects of friendship for children with high ADHD symptoms. The objective of the current study was to examine the associations between children's ADHD symptoms and their friendship patterns over an academic year. We also tested whether reciprocated friendship may buffer against the risk for other peer relationship difficulties associated with ADHD symptoms.

ADHD and Peer Relationship Difficulties

For children with elevated symptoms of ADHD, peer relationships are often challenging (Gardner & Gerdes, 2015). Inattention can inhibit children's capacity to notice social cues, while hyperactivity/impulsivity can lead to unrestrained social behaviors (see Gardner & Gerdes, 2015; Mikami, 2010, for

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review). The core symptoms of ADHD may explain why, in observational studies, children with ADHD demonstrate behaviors such as violations of game rules and insensitivity to peers' needs (Normand et al., 2013).

In part because of their poor social behaviors, children with ADHD symptoms are documented to show a wide range of peer relationship difficulties in the classroom. Over half of children with ADHD are considered to be peer-rejected on sociometric measures completed by classmates (defined as being disliked by many peers and liked by few; Hoza et al., 2005), relative to 14% of comparison children. ADHD symptoms also put children at risk for peer victimization. In one study, 27% of the children with ADHD, relative to 4% of those without ADHD, were classified as victims (Wiener & Mak, 2009). A study of young adolescents with ADHD found that 57% reported having at least one victimization experience every week, including relational (51%), reputational (17%), and physical victimization (14%; Becker et al., 2017). Further, children with ADHD symptoms report receiving less social support from their classmates than do comparison peers (Demaray & Elliott, 2001).

In addition to the robust findings that ADHD symptoms are cross-sectionally associated with peer problems, some research also suggests that ADHD symptoms incrementally predict more social difficulties over time. In a community sample of elementary school students followed over 1 year, children's initial inattentive symptoms predicted lower peer acceptance and fewer reciprocated friends 6 months later, which in turn predicted higher symptoms of inattention and hyperactivity/impulsivity at study end (Tseng et al., 2014). These findings suggest a vicious cycle between ADHD symptoms and peer impairment. Another 6-year longitudinal study indicated that a childhood diagnosis of ADHD led to cascading cycles of increasing peer rejection and poor social skills, with the conclusion that the social impairment of children with this condition worsens over time (Murray-Close et al., 2010).

Whereas good peer relationships are thought to set the stage for healthy adjustment in adolescence and adulthood, impairments in the peer context can spill over into other domains of functioning. Peer difficulties incrementally predict subsequent academic failure, delinquency, and mental health problems, including for children with ADHD (Bagwell et al., 2001; Mrug et al., 2012). These findings suggest the research and clinical importance of understanding peer relationship problems associated with ADHD symptoms, as well as buffers of peer difficulties.

ADHD and Friendship

Friendship is a mutual relationship between two children, and is a distinct construct from other aspects of peer functioning. A child could be unfavorably regarded by the peer group at large and have generally unsupportive peer experiences that include victimization, but could nonetheless have a friend. Relative to peer acceptance, friendship is thought to provide a unique opportunity for loyalty, affection, and alliance (Parker & Asher, 1993). Friendship may require, and facilitate, particular social skills in children that are relevant for close relationships, such as trust and negotiation (Bagwell et al., 2001).

Relatively fewer studies have examined friendship patterns in children with ADHD, compared to the much larger body of literature documenting other peer relationship problems in this population. Notably, although children with ADHD may report the same number of friends as do comparison children, their self-reported friendships are less often corroborated by their parents and teachers (Marton et al., 2015). On sociometric measures, studies find that children with ADHD have few reciprocated friends in their classroom (where both the child and the peer nominate one another as a friend; Blachman & Hinshaw, 2002; Hoza et al., 2005), relative to comparison peers. In addition to being fewer in number, the friendships of children with ADHD are also suggested to have poorer quality (e.g., less warmth, more conflict) relative to the friendships of comparison children (Blachman & Hinshaw, 2002; Normand et al., 2013).

More concerning, perhaps, is research suggesting that ADHD symptoms may also be linked with difficulties in maintaining friendships over time. According to child and parent reports, the average duration of friendships of children with ADHD is shorter than that of children without ADHD (Marton et al., 2015). Using sociometric measures, another study showed that girls with ADHD exhibited more difficulties than comparison girls in maintaining consistent friendships with the same classmate during a 5-week summer program, which might be related to negative relationship features in the friendships of the girls with ADHD (Blachman & Hinshaw, 2002). Finally, friends of children with ADHD reported deterioration in their friendship quality over a 6-month period (i.e., less positive features, more conflict, less friendship satisfaction), in contrast to the reports of the friends of comparison children about improved friendship quality and satisfaction during the same period (Normand et al., 2013).

Research on friendship and ADHD has, so far, considered reciprocated friendships, where both children mutually recognize each other as a friend (Parker & Asher, 1993). Although reciprocity is acknowledged as essential to establish that a friendship exists, an exclusive focus on such friendships means that children are classified as either having "reciprocated friends" versus "no friends at all" (Berndt & McCandless, 2009). A more nuanced classification of friendship may be useful, especially for children with ADHD symptoms, to identify the specific friendship aspects they may lack. That is, children with ADHD symptoms may find it difficult to recognize other

peers as their friends, to be selected as friends by their peers, or both. Crucially, unilateral friendships (i.e., those that are one-sided) can be distinguished into two types (e.g., Lodder et al., 2017). There are unchosen friends who nominate the child as a friend while the child does not return this nomination, and there are unreciprocated friends who the child nominates as friends but do not nominate the child in return. A child with no reciprocated friends could have many unreciprocated friends, many unchosen friends, both, or neither – with each situation having different causes and intervention implications.

There is also research suggesting that unilateral friendships differ from relationships with non-friends in that the former show more positive engagement, conflict resolution, and reciprocal and intimate properties of affiliation such as similarity, closeness, and loyalty (Newcomb & Bagwell, 1995). A study in a community sample suggested that having more unilateral friends, and not just more reciprocated friends, was cross-sectionally related to lower loneliness (Lodder et al., 2017). Indeed, this raises the intriguing possibility that having unilateral friendships may represent better functioning than having no friendship ties at all. Thus, understanding the taxonomy of reciprocated, unchosen, unreciprocated, and non-friends is important for gaining a comprehensive picture of how friendship is associated with ADHD symptoms. To our knowledge, there are no studies that consider the different types of unilateral friendships that may exist for children with elevated ADHD symptoms.

Protective Role of Reciprocated Friendship

Literature in community samples has suggested the protective role of reciprocated friendship in promoting good adjustment, especially self-esteem and feelings of belonging. Having more reciprocated friends and higher friendship quality at school incrementally predicted children's lower loneliness across the transition between 5th and 6th grade; this association was found after statistical control of children's peer acceptance (Kingery et al., 2011). Reciprocated friendship has also been found to mitigate the adverse impacts of negative peer experiences. Whereas peer victimization (Hodges et al., 1999) and peer rejection (Laursen et al., 2007) prospectively predicted increases in internalizing and externalizing problems across a 1-year period for children without reciprocated friends, these associations were attenuated for children with at least one friend. It is thought that friendship confers emotional support and a sense of companionship that might help a child remain emotionally resilient, while also providing opportunities to acquire interpersonal skills for building relationships with other peers in the future.

Taken together, this literature suggests the potential for reciprocated friendship to mitigate against social difficulties associated with ADHD symptoms, as discussed by Mikami (2010). A few studies involving ADHD samples have examined the buffering effects of friendship against negative social outcomes, and have yielded mixed findings. In a 5-week summer program for girls with and without ADHD, having at least one reciprocated friend attenuated the associations between children's externalizing behavior and peer victimization (Cardoos & Hinshaw, 2011). However, another study found that for children with and without ADHD in a 2-week summer program, having more reciprocated friends reduced the positive association between externalizing behavior and peer victimization for boys, yet exacerbated this association for girls (Jia & Mikami, 2015). The authors proposed that girls with externalizing behaviors may experience bullying and victimization within friend dyads in the form of relational conflicts (Jia & Mikami, 2015). On the other hand, Mrug et al. (2012) found that the presence of a reciprocated friendship did not moderate the detrimental impact of peer rejection on increased depression, delinquency, anxiety, and substance use 6-8 years later among children with ADHD.

Only two studies, to our knowledge, have examined the potential for friendship to buffer against the effects of ADHD (or ADHD symptoms) on social problems. First, among children ages 5-13 attending an afterschool program, Becker et al., (2013) reported that children's perceptions of the intimate exchange in their best friendship mitigated the prospective association between ADHD symptom severity and social problems as rated by the program director 1 year later. Although this study suggests the protective role of friendship, the conclusions are limited because children self-reported on the quality of their best friendship; whether this friendship existed (or was reciprocated) was never assessed, nor was friendship quantity measured. The second study involved students beginning university. The number of reciprocated friends established with peers in an orientation program was more strongly associated with greater self-perceptions of social belonging at their university for participants with high ADHD symptoms, relative to those with low ADHD symptoms (Khalis et al., 2018). This was found after statistical control of peer acceptance in the orientation program, and in this study, reciprocated friendships were validated using sociometric measures. Khalis et al. (2018) again suggests the potential for friendship to protect against social difficulties associated with ADHD, but the findings from university students (a potentially high functioning group, in a different developmental period) may not generalize to elementary school-age children.

Although it is theoretically possible that the benefits of friendship could extend to relationships that are unilateral,

the evidence is strongest for reciprocity as providing the necessary context for social and emotional benefits to accrue (Bagwell et al., 2001). Nonetheless, to our knowledge, no research has examined buffering effects of unilateral friendships (e.g., unchosen or unreciprocated friendships) on difficulties associated with ADHD symptoms, or compared any effects for unilateral friendships to effects for reciprocated friendships.

Current Study

We examined the associations between children's ADHD symptoms with their friendship patterns and peer relationships, in a community sample of elementary school students followed over one school year. Peer functioning was assessed in the classroom, which is an ecologically-valid context to examine peer relationships among school-age children. Using sociometric measures, we took a nuanced view of friendship to include the four types of friendship ties with classmates: reciprocated friends, unchosen friends, unreciprocated friends, or non-friends.

Our first research question tested cross-sectional associations between children's ADHD symptoms and peer relationships. We hypothesized that higher ADHD symptoms would be correlated with poorer friendship patterns (i.e., fewer reciprocated and unchosen friends, and more unreciprocated and non-friends), as well as poorer social preference, less perceived peer support, and more victimization, in the fall of the academic year (Hypothesis1). Second, we examined how children's ADHD symptoms in fall predict their peer relationships over time. We hypothesized that, after statistical control of fall scores on these outcome variables, higher fall ADHD symptoms would predict poorer friendship patterns, poorer social preference, less peer support, and more victimization in spring (Hypothesis 2). Third, we tested if reciprocated friendships mitigate the risk for negative peer outcomes associated with children's ADHD symptoms. We hypothesized that fall reciprocated friendship would moderate the associations found in Hypothesis 2, such that children with more reciprocated friends in fall would have a weaker association between fall ADHD symptoms and spring peer problems, relative to children with fewer reciprocated friends in fall (Hypothesis 3). As an exploratory analyses, we examined whether the protective benefits of reciprocated friendship extend to unchosen and unreciprocated friendships. Finally, given the potential for each symptom dimension to differentially affect peer functioning (e.g., Tseng et al., 2014), we explored whether patterns obtained in Hypotheses 1-3 are consistent across inattention and hyperactivity/impulsivity symptoms.

Method

Participants

Participants were 558 children (275 girls, 283 boys; ages 4-10, M = 7.50, SD = 1.31), taking part in a larger investigation testing the effects of a classroom intervention on children's academic and social functioning (Mikami et al., 2020). The children were students in 34 classrooms (grades K-5) located in 11 schools across western Canada (n = 270 children) or the midwestern United States (n = 288 children). Participants' racial backgrounds were: White (n = 223), Black (n = 87), Asian Canadian or Asian American (n = 110), Multiracial (n = 93), and Other (n = 45).

Procedure

Information about the larger investigation was introduced at school staff meetings or through emails from school principals to their teachers. Interested teachers contacted the study team and provided consent to participate. At the start of the school year, participating teachers were asked to distribute study information to all parents of children in their classrooms. Parents who agreed to have their children take part in the study provided consent, and their children assented. The average child participation rate across our 34 classrooms was 69% (range: 48-96%). The suggested cut-off is a 50% participation rate for sociometric data (McKown et al., 2011). When we excluded the one classroom with a 48% participation rate, all results remained significant, and no new significant results appeared; thus we retained these students in the sample.

One month into the school year (to allow teachers time to know students), teachers reported on the consented children's ADHD symptoms. At this time, sociometric assessments and children's self-reports of classroom social experiences were collected in individual interviews where research assistants read each question aloud to the child, used a graphic to explain the rating scales, checked for the child's comprehension of each item, and recorded the child's responses. This assessment was considered to be the baseline, or fall timepoint. All measures were administered again in the last month of school as a post-test or spring timepoint.

As part of the larger investigation, participating teachers were randomly assigned to implement a classroom intervention with the goal of improving children's academic and social functioning (n = 17 classrooms) or to form a typical practice control group (n

= 17 classrooms). Findings regarding the efficacy of the intervention are reported in Mikami, Owens, et al. (2020); however, there were no intervention effects on any of the measures included in the current study. Nonetheless, we controlled for the intervention versus control status of the classroom in all our analyses with the spring outcomes. All procedures were approved by the university review boards at the University of British Columbia and Ohio University and associated school district review boards at each site.

Measures

Teacher reports of children's ADHD symptoms. Teachers completed the ADHD-5 Rating Scale about children's ADHD symptoms (DuPaul et al., 2016). This scale assesses the degree to which children display the nine inattentive and nine hyperactive/impulsive symptoms of ADHD listed in the DSM-5. Each symptom is rated on a 4-point scale (0 = *never or rarely*, 1 = *sometimes*, 2 = *often*, and 3 = *very often*). In our sample, internal consistency was $\alpha = 0.96$ for inattentive ($M = 5.14$, $SD = 6.80$) and $\alpha = 0.95$ for hyperactive/impulsive symptoms ($M = 7.78$, $SD = 7.80$). The correlation between inattention and hyperactivity/impulsivity was $r = 0.76$ ($p < 0.001$) supporting our decision to create a total ADHD symptom score by summing the scores on the 18 items ($M = 12.93$, $SD = 13.71$).

Friendship nominations. Children completed a standard sociometric procedure (Coie et al., 1982). To facilitate recall, children were provided with the names and pictures of consented classmates. Children were asked to nominate an unlimited number of friends ("Someone who you would call your friend. A friend is someone who you are close to and you do things together") among consented classmates. Following methodology used in previous research (Lodder et al., 2017), we considered who the child did and did not nominate as a friend, and similarly, the classroom peers who did and did not nominate the child as a friend, to define four types of dyads, described below.

When the child and classmate mutually nominated one another as a friend, this classmate was considered to be a reciprocated friend. When the child received a unilateral friendship nomination from a classmate who was not nominated by the child in return, the classmate was an unchosen friend. When the child gave a unilateral friendship nomination to a classmate who did not reciprocate this nomination, this classmate was an unreciprocated friend. Finally, when neither the child or a classmate nominated the other as a friend, we refer to the classmate as a non-friend. We then calculated the proportion of consented classmates categorized in each type.

Social preference. In the same sociometric interview that was used to assess friendship patterns, children were also asked to nominate an unlimited number of consented classmates who they liked (i.e., positive nominations) and who they did not like (i.e., negative nominations). A social preference score for each child was computed by subtracting the number of negative nominations received from the number of positive nominations received, and dividing that value by the number of peers who participated in the sociometric procedure.

Children's perceptions of peer support. The Classroom Life Measure was used to assess children's perceptions of the emotionally supportive relationships with peers in their classroom (CLM; Johnson et al., 1985). We included the composite score reflecting peer emotional support (e.g., "In this class, other students care about my feelings"; 5 items). In our sample, the internal consistency was $\alpha = 0.76$ Each item is scored on a five-point Likert scale anchored by 1 = *never*, 2 = *a little*, 3 = *somewhat*, 4 = *pretty much*, and 5 = *always*. We took the mean of the 5 items on this scale, where higher scores indicate higher peer support.

Children's self-reported victimization experiences. Children completed the Social Experience Questionnaire (SEQ; Crick & Grotpeter, 1996) to assess their subjective experiences of victimization by classroom peers. The SEQ includes assessment of relational victimization (5 items, e.g., "How often does a kid try to keep others from liking you by saying mean things about you?") and overt victimization (5 items, e.g., "How often are you hit by another kid at school?"). In our sample, internal consistency was $\alpha = 0.76$ for relational victimization and $\alpha = 0.77$ for overt victimization. Items are rated on a three-point Likert scale anchored by 1 = *never*, 2 = *sometimes*, and 3 = *almost all the time*. We calculated the mean of the relational victimization items and the mean of the overt victimization items for each child.

Data Analytic Plan

Data analyses were conducted using the lme4 package in R (Bates et al., 2015), with a multilevel modeling approach to account for children (Level 1) being nested within classrooms (Level 2). Children's ADHD symptoms were grand mean centered in order to improve interpretability of the results. To account for the classroom contextual effect, we controlled for the average level of ADHD symptoms in each classroom.

Hypothesis 1. We first tested the cross-sectional associations between children's ADHD symptoms and their peer functioning in fall. The four friendship variables (reciprocated friends, unchosen friends, unreciprocated friends, and non-friends), social preference, peer support, and relational and overt victimization, were each entered as outcomes in separate models.

Level 1: Fall peer functioning$_{ij}$ = β_{0j} + β_{1j}(ADHD symptoms$_{ij}$) + e_{ij}

Level 2: β_{0j} = γ_{00} + γ_{01}(classroom ADHD symptom mean$_j$) + u_{0j}

$\beta_{1j} = \gamma_{10}$

Hypothesis 2. Next, we tested how children's ADHD symptoms in fall predict their peer functioning in spring. We controlled for the same variable of peer functioning in fall (Level 1) and whether the child's classroom was in the intervention or control condition (Level 2).

Level 1: Spring peer functioning$_{ij}$ = β_{0j} + β_{1j}(ADHD symptoms$_{ij}$) + β_{2j}(fall peer functioning$_{ij}$) + e_{ij}

Level 2: β_{0j} = γ_{00} + γ_{01}(classroom ADHD symptom mean$_j$) + γ_{02}(intervention condition$_j$) + u_{0j}

$\beta_{1j} = \gamma_{10}$

$\beta_{2j} = \gamma_{20}$

Hypothesis 3. Finally, we tested the interaction between children's ADHD symptoms and reciprocated friendship in fall in predicting peer functioning in spring. This interaction term was added to the Hypothesis 2 models.

Level 1: Spring peer functioning$_{ij}$ = β_{0j} + β_{1j}(ADHD symptoms$_{ij}$) + β_{2j} (reciprocated friends$_{ij}$) +

β_{3j}(fall peer functioning$_{ij}$) + β_{4j} (ADHD symptoms$_{ij}$ × reciprocated friends$_{ij}$) + e_{ij}

Level 2: β_{0j} = γ_{00} + γ_{01}(classroom ADHD symptom mean$_j$) + γ_{02}(intervention condition$_j$) + u_{0j}

$\beta_{1j} = \gamma_{10}$

$\beta_{2j} = \gamma_{20}$

$\beta_{3j} = \gamma_{30}$

$\beta_{4j} = \gamma_{40}$

Exploratory analyses. We repeated the analyses testing Hypotheses 3 while substituting first unchosen friends, and then unreciprocated friends, in place of reciprocated friends, to determine whether unilateral friendships had a similar buffering effect. Additionally, we repeated the analyses testing Hypotheses 1-3 while substituting first inattentive symptoms, and then hyperactive/impulsive symptoms, in place of total ADHD symptoms, to determine whether the results remained consistent across symptom domains.

Results

Descriptive Statistics

Table 1 summarizes the means and standard deviations for and correlations among study measures. We note that children above the 90th percentile in symtoms for their age and gender in the ADHD-5 norming sample are suggested to be at risk for ADHD (DuPaul et al., 2016). Applying this criteria to our sample, 60 children (10.9%) were identified as at risk for ADHD. Although there are no official cutoffs to identify children at risk on the friendship measures, in the fall, 64 children (11.7%) had no reciprocated friends, 145 children (26.6%) had one friend, and 336 (61.7%) had two or more friends among consented classmates. Among the 60 children in the at risk range on ADHD symptoms, 12 (20.0%) had no reciprocated friends, suggesting a higher likelihood of having no friends in this group. At the bivariate level, higher ADHD symptoms in fall were correlated with smaller proportions of reciprocated friends and unchosen friends in both fall and spring, a greater proportion of unreciprocated friends in fall, and a greater proportion of non-friends in spring. Higher fall ADHD symptoms also correlated with child perceptions of lower peer support and more relational and overt victimization in fall and spring.

Missing data (of 558 participants, 8 to 21 cases in the fall, 0 to 32 cases in the spring, depending on the measure) were attributable to children joining the classroom after the school year had started or leaving before the school year ended. There were no differences between children with versus without missing data on any demographic variable. Missing data were handled using full information maximum likelihood estimation in data analyses.

Cross-Sectional Associations Between ADHD Symptoms and Peer Functioning in Fall

Table 2 summarizes the findings from Hypothesis 1, which accounts for the nested structure of the data. Higher ADHD symptoms were related to children having fewer reciprocated and unchosen friends, and more unreciprocated friends and non-friend classmates, at the fall timepoint. Regarding other indicators of peer functioning, higher ADHD symptoms were also cross-sectionally associated with lower social preference, receipt of more relational and overt victimization, and lower peer support in the fall. The addition of ADHD symptoms to the model incrementally accounted for 1-22% of the variance across outcome measures.

Longitudinal Associations Between Fall ADHD Symptoms and Spring Peer Functioning

Table 2 also presents the analyses testing the effect of fall ADHD symptoms on spring friendship patterns and peer functioning (Hypothesis 2). Higher ADHD symptoms in fall predicted fewer unchosen friends and more non-friend classmates in spring, adjusting for friendship patterns in fall. Similarly, higher ADHD symptoms in fall predicted lower social preference and higher receipt of relational and overt victimization in spring after accounting for the fall levels of these constructs. The

Table 1 Descriptive Statistics of Study Variables

Measures	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
Fall																	
1. ADHD Symptoms																	
2. R Friends	-0.19***																
3. UC Friends	-0.14**	-0.07															
4. UR Friends	0.14**	0.07	-0.40***														
5. Non-friends	0.08	-0.61***	-0.28***	-0.58***													
6. Social Preference	-0.22***	0.08	0.48***	-0.54***	0.08												
7. Peer Support	-0.14**	0.17***	0.06	0.05	-0.18***	-0.08											
8. R Victimization	0.22***	-0.12**	0.01	0.18***	-0.08	-0.19***	-0.17***										
9. O Victimization	0.22***	-0.04	-0.02	0.15***	-0.08	-0.21***	-0.15	0.66***									
Spring																	
10. R Friends	-0.13**	0.40***	0.07	-0.02	-0.26***	0.13**	0.13**	-0.19***	-0.14**								
11. UC Friends	-0.22***	0.12**	0.32***	-0.13**	-0.17***	0.30***	0.04	-0.01	-0.01	-0.13**							
12. UR Friends	0.08	0.03	-0.12**	0.29***	-0.17***	-0.21***	-0.03	0.07	0.06	0.00	-0.34***						
13. Non-friends	0.14**	-0.32***	-0.15**	-0.16***	0.40***	-0.08	-0.06	0.06	0.04	-0.48***	-0.29***	-0.64***					
14. Social Preference	-0.22***	0.07	0.23***	-0.22***	-0.01	0.34***	-0.00	-0.14**	-0.14**	0.05	0.45***	-0.48***	0.09*				
15. Peer Support	-0.09*	0.22***	0.06	0.06	-0.21***	-0.01	0.48***	-0.19***	-0.18***	0.23***	0.02	0.05	0.05	-0.07			
16. R Victimization	0.25***	-0.07	-0.06	0.07	0.03	-0.15**	-0.17***	0.49***	0.43***	-0.10*	-0.10*	0.06	0.06	-0.14**	-0.23***		
17. O Victimization	0.26***	-0.03	-0.04	0.04	0.01	-0.07	-0.11*	0.37***	0.48***	-0.04	-0.10*	0.09*	0.01	-0.16***	-0.21***	0.69***	
Mean	12.93	0.14	0.14	0.14	0.56	0.18	3.84	2.69	2.49	0.15	0.14	0.15	0.57	0.16	3.75	2.65	2.36
SD	13.71	0.11	0.12	0.15	0.19	0.28	0.87	2.51	2.37	0.11	0.12	0.16	0.19	0.28	0.92	2.43	2.30
N	550	545	545	545	545	547	548	545	537	530	530	530	530	558	529	529	526

R Friends = Reciprocated Friends, *UC* Friends = Unchosen Friends, *UR* Friends = Unreciprocated Friends, *R* Victimization = Relational Victimization, *O* Victimization = Overt Victimization
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table 2 Regression Parameters for Fall ADHD Symptoms Predicting Each Peer Relationship Variable in Fall and in Spring

	ADHD Symptoms *B (SE)*	*n*	*t*	Proportion of Variance
Fall Friendship Variables				
Reciprocated Friends	-0.002 (0.0003)***	543	-5.58	0.07
Unchosen Friends	-0.002 (0.0004)***	543	-4.23	0.03
Unreciprocated Friends	0.002 (0.0005)**	543	3.13	0.01
Non-friends	0.002 (0.0005)***	543	3.71	0.02
Social Preference	-0.010 (0.0008)***	545	-11.96	0.22
Peer Support	-0.009 (0.003)**	546	-2.96	0.01
Relational Victimization	0.04 (0.008)***	543	5.03	0.04
Overt Victimization	0.04 (0.008)***	535	4.79	0.04
Spring Friendship Variables				
Reciprocated Friends	-0.0004 (0.0003)	516	-1.35	0.00
Unchosen Friends	-0.002 (0.0004)***	516	-5.01	0.05
Unreciprocated Friends	0.0003 (0.0005)	516	0.64	0.00
Non-friends	0.002 (0.0005)***	516	3.73	0.03
Social Preference	-0.003(0.0005)***	545	-5.82	0.06
Peer Support	-0.005 (0.003)	518	-1.62	0.00
Relational Victimization	0.02 (0.008)***	516	3.31	0.02
Overt Victimization	0.02 (0.008)***	507	3.22	0.02

Children were nested in 34 classrooms. Classroom average ADHD scores were controlled for all analyses. All analyses predicting the spring outcomes statistically controlled for the fall levels of the outcome variable (Level 1), classroom average ADHD scores (Level 2), and intervention condition (Level 2). Proportion of variance accounted for was calculated by comparing the unexplained within-cluster variance of the full model with ADHD scores added (both grand-mean-centered and classroom average scores) and the variance of the base model without the ADHD scores; i.e., $(\sigma^2_{base} - \sigma^2_{full})/\sigma^2_{base}$

$^{**}p < 0.01$; $^{***}p < 0.001$

addition of ADHD symptoms to the model incrementally accounted for 2-6% of the variance across outcome measures. ADHD symptoms did not incrementally predict reciprocated friends, unreciprocated friends, or peer support in spring.

The Moderating Role of Reciprocated Friendship

Table 3 displays the results for Hypothesis 3. There were interaction effects between fall ADHD symptoms and fall reciprocated friends for the outcomes of spring reciprocated friends, non-friend classmates, and self-perceptions of peer support. We used simple slope analysis to estimate the associations for children 1 *SD* below, at, and 1 *SD* above, the grand-centered mean for reciprocated friends (Preacher et al., 2006). In practical terms, given that the average number of consented classmates was 15, a child 1 *SD* below the mean of our sample (proportion score of 0.03) had approximately no reciprocated friends, a child at the mean (proportion score of 0.14) had about 2 reciprocated friends, and a child 1 *SD* above the mean (proportion score of 0.25) had close to 4 reciprocated friends, among consented classmates.

Figure 1 displays these results. For children 1 *SD* below the mean of reciprocated friends in fall, higher ADHD symptoms predicted fewer reciprocated friends ($b = -0.002$, $SE = 0.0004$, $p < 0.001$), more non-friend classmates ($b = 0.003$, $SE = 0.0007$, $p < 0.001$), and lower peer support ($b = -0.01$, SE $= 0.004$, $p = 0.004$) in spring. For children at the mean of reciprocated friends in fall, ADHD symptoms predicted more non-friend classmates ($b = 0.001$, $SE = 0.0005$, $p = 0.02$), but were not associated with reciprocated friends ($b = -0.0002$, $SE = 0.0003$, $p = 0.61$) or peer support in spring ($b = -0.0008$, $SE = 0.003$, $p = .79$). In contrast, for children 1 *SD* above the mean of reciprocated friends in fall, ADHD symptoms were not associated with non-friend classmates ($b = -0.0003$, $SE = 0.0009$, $p = 0.75$), and predicted more reciprocated friends ($b = 0.001$, $SE = 0.0005$, $p = 0.03$) and marginally higher peer support ($b = 0.009$, $SE = 0.005$, $p = 0.05$) in spring. Thus, having more reciprocated friends in fall buffered against the longitudinal associations between children's ADHD symptoms in fall and poorer peer functioning in spring.

Table 3 The Moderating Role of Friendship in Fall on Associations between Fall ADHD Symptoms and Spring Peer Functioning

	Spring Reciprocated Friends B (SE)	Spring Non-friends B (SE)	Spring Peer Support B (SE)
Model 1. Moderating Role of Fall Reciprocated Friends			
ADHD Symptoms	-0.002 (0.0005)***	0.003 (0.0008)***	-0.01 (0.004)**
Fall Reciprocated Friends	0.40 (0.04)***	-0.37 (0.08)***	1.27 (0.35)***
ADHD Symptoms × Fall Reciprocated Friends	0.012 (0.003)***	-0.01 (0.005)**	0.09 (0.03)**
Model 2. Moderating Role of Fall Unchosen Friends			
ADHD Symptoms	-0.002 (0.0005)***	0.003 (0.0008)***	-0.005 (0.004)
Fall Unchosen Friends	0.06 (0.04)	-0.02 (0.05)	0.09 (0.31)
ADHD Symptoms × Fall Unchosen Friends	0.007(0.003)*	-0.009 (0.004)*	0.003 (0.02)
Model 3. Moderating Role of Fall Unreciprocated Friends			
ADHD Symptoms	0.0004 (0.0004)	-0.00003(0.0007)	-0.006 (0.004)
Fall Unreciprocated Friends	-0.005 (0.03)	0.16 (0.06)**	0.20 (0.24)
ADHD Symptoms × Fall Unreciprocated Friends	-0.005 (0.002)**	0.009 (0.003)**	0.003 (0.02)

Children were nested in 34 classrooms. $n = 516$ children for analyses predicting spring reciprocated friends and non-friends; $n = 514$ children for analyses predicting spring peer support. All analyses statistically controlled for the fall levels of the outcome variable (Level 1), classroom average ADHD scores (Level 2), and intervention condition (Level 2)

**$p < 0.01$; ***$p < 0.001$

Exploratory Analyses: Unchosen and Unreciprocated Friendships

These results are in Table 3. When substituted for fall reciprocated friends, fall unchosen friends buffered against the association between fall ADHD symptoms and reciprocated friends, as well as non-friends, in spring. For children 1 *SD* below the mean on unchosen friends, ADHD symptoms predicted fewer reciprocated friends ($b = -0.002$, $SE = 0.0005$, $p < 0.001$) and more non-friends ($b = 0.003$,

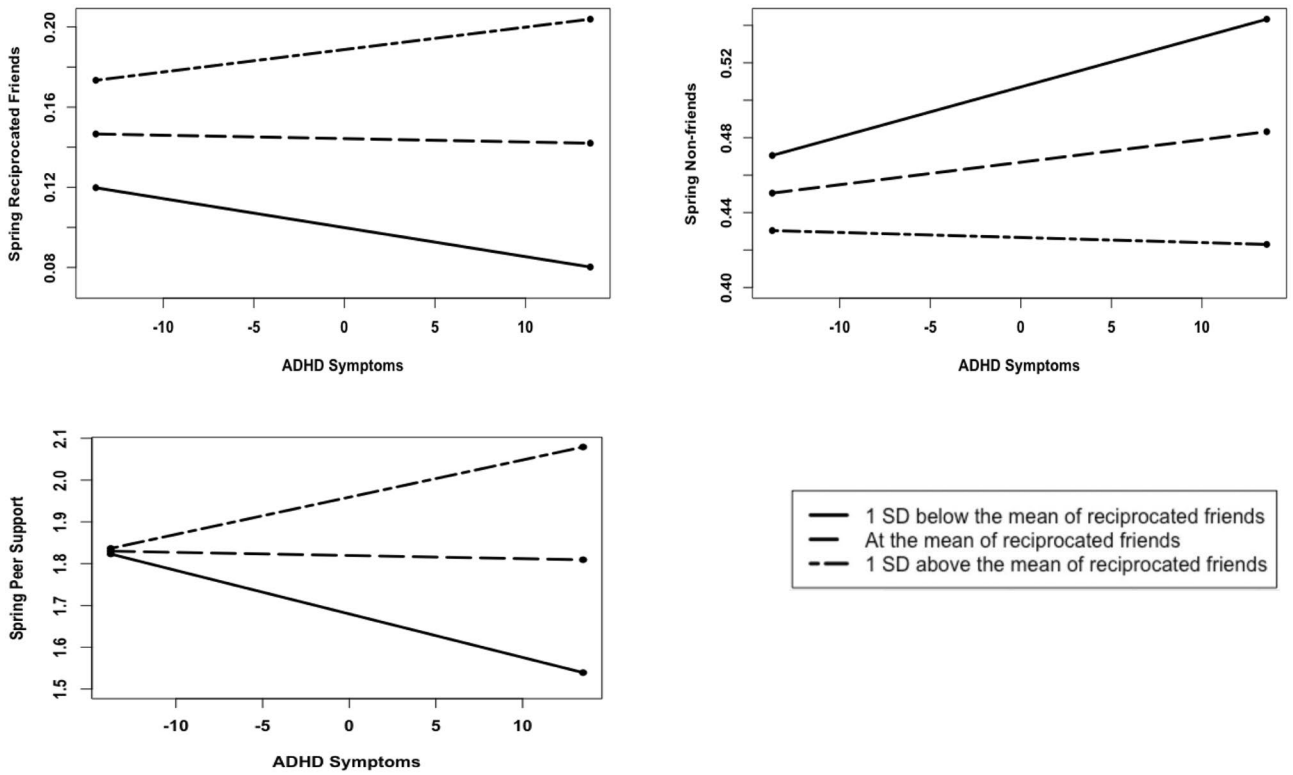

Fig. 1 Simple Slopes of Children with High and Low Reciprocated Friendships in Fall Predicting Spring Peer Functioning

$SE = 0.0007$, $p < 0.001$) in spring. Children 1 *SD* above the mean on unchosen friends had no relationship between ADHD symptoms and spring reciprocated friends ($b = -0.0002$, $SE = 0.0005$, $p = 0.73$) or non-friends ($b = 0.0008$, $SE = 0.0008$, $p = 0.32$).

The opposite pattern was found for fall unreciprocated friends. For children 1 *SD* below the mean of unreciprocated friends, there was no significant relationship between fall ADHD symptoms and spring reciprocated friends ($b = 0.0005$, $SE = 0.0004$, $p = 0.29$) or non-friends ($b = -0.0001$, $SE = 0.0007$, $p = 0.88$). But, for children 1 *SD* above the mean of unreciprocated friends, fall ADHD symptoms were associated with fewer reciprocated friends ($b = -0.001$, $SE = 0.0004$, $p = 0.006$) and more non-friend classmates ($b = 0.003$, $SE = 0.0007$, $p < 0.001$) in spring. Unlike as was found for reciprocated friends, there were no interaction effects for unchosen or unreciprocated friends for the spring outcome of children's self-perceived peer support.

Exploratory Analyses: Inattentive Versus Hyperactive/Impulsive Symptoms

When data analyses were repeated with inattentive and then hyperactive/impulsive symptoms substituted for total ADHD symptoms, all significant results obtained in Hypotheses 1, 2, and 3 remained for both individual symptom domains. In addition to these results, fall reciprocated friends also moderated the relationship between hyperactivity/impulsivity and social preference in spring ($b = 0.07$, $SE = 0.02$, $p < 0.001$). For children 1 *SD* below the mean of reciprocated friends in fall, fall hyperactivity/impulsivity predicted significantly poorer social preference in spring ($b = -0.02$, $SE = 0.002$, $p < 0.001$); but for children 1 *SD* above the mean of reciprocated friends in fall, fall symptoms were only marginally associated with poorer social preference in spring ($b = -0.005$, $SE = 0.003$, $p = 0.07$). See Supplementary Tables S1 and S2.

Discussion

Peer functioning is a pronounced domain of impairment in children with ADHD symptoms, and one of the most difficult to treat (Gardner & Gerdes, 2015). The current study extends the existing literature to examine the associations between children's ADHD symptoms and their friendship patterns in a community sample of elementary school students. We found that ADHD symptoms were associated with children having fewer reciprocated and unchosen friends, and more non-friends and unreciprocated friends, in their classroom in fall, in addition to other indicators of peer problems. Higher ADHD symptoms in fall also predicted children having fewer unchosen friends, as well as more non-friend classmates, lower social preference, and more peer victimization in spring, after statistical control of fall levels of these constructs. However, reciprocated friendships buffered some associations between ADHD symptoms and negative peer experiences over time.

ADHD Symptoms and Peer Functioning

Consistent with the substantial literature documenting peer problems among children with symptoms or diagnoses of ADHD (Gardner & Gerdes, 2015), we found that higher ADHD symptoms were cross-sectionally related to children's lower social preference and peer support, and higher receipt of victimization. Our findings underscore the robust peer relationship difficulties associated with ADHD symptoms, existing across measures and informants, and suggest that they are evident as soon as 1 month into the school year.

Extending this literature, we also examined the cross-sectional associations between children's ADHD symptoms and their friendship patterns. Children with ADHD have been documented to have fewer reciprocated friends (Blachman & Hinshaw, 2002; Hoza et al., 2005). In this community sample, we found that higher ADHD symptoms were related to not only fewer reciprocated friends, but also to fewer unchosen friends, more unreciprocated friends, and more non-friends. This nuanced finding is important because it is possible for a child to have no reciprocated friends because they do not nominate any classmates as friends, or conversely, or it could be because they nominate everyone but nobody returns the nomination. Our results suggest that ADHD symptoms are associated with a pattern of unilaterally nominating classmates without the classmates returning the nominations (i.e., fewer unchosen friends and more unreciprocated friends). Our findings from sociometric measures appear consistent with previous findings that children with ADHD report no fewer number of friends than comparison children, but their self-reported friendships are not corroborated by teachers or parents (Marton et al., 2015). This result may reflect positive bias, or the tendency for children with ADHD to have more positive self-perceptions of their own social competence than are reported by others about the children with ADHD (e.g., Owens et al., 2007). That is, in our data, ADHD symptoms in children may be correlated with a tendency to perceive that they have many friends, without this perception being shared by their classmates.

Unfortunately, our longitudinal findings suggested that children's higher ADHD symptoms in fall also predicted their poorer peer relationships in spring, after adjusting for peer relationships in fall. Elevated fall ADHD symptoms were related to children's reports of greater relational and overt victimization experiences in the classroom, and poorer social preference, in spring. We also found that higher fall ADHD

symptoms were associated with having fewer unchosen friends and more non-friends in spring, suggesting a pattern of losing unilateral friendships over the course of the school year and becoming more isolated from peers. These results are in line with previous findings about deterioration in peer relationships of children with ADHD symptoms, including greater peer rejection, fewer reciprocated friendships, and poorer friendship quality over time (Normand et al., 2013; Tseng et al., 2014). However, the current study builds on this existing literature by suggesting that ADHD symptoms may be associated with a specific pattern of children receiving fewer friendship nominations (i.e., fewer unchosen friends), as opposed to children giving fewer friendship nominations, over the course of the school year. Perhaps these longitudinal results occurred because ADHD symptoms set off a cascading, negative cycle where peer problems associated with ADHD deprive children of opportunities to learn and practice social skills in peer interactions and their impaired social skills may, in turn, lead to greater peer difficulties (Murray-Close et al., 2010).

Friendship as a Buffer of Negative Peer Experiences

Our findings provide promising evidence that reciprocated friendship in fall can potentially mitigate the longitudinal associations between children's fall ADHD symptoms and negative peer outcomes in spring. When children had fewer reciprocated friends in fall, elevated ADHD symptoms predicted more non-friends, fewer reciprocated friends, and lower perceptions of peer support in spring – all of which are indicators of worse peer relationships over time. However, when children had more reciprocated friends in fall, ADHD symptoms no longer predicted the number of non-friends and even predicted children having more reciprocated friends and perceiving marginally more support from peers in spring. When looking at the separate symptom dimensions, reciprocated friendship also buffered the negative effect of hyperactivity/impulsivity symptoms on social preference in spring.

One possible mechanism is that reciprocated friends help children with ADHD symptoms to learn and practice social skills for building more effective peer relationships. Friendship is thought to lead to development of key social skills, and reciprocated friendship in particular is characterized by intense engagement between friends, including frequent interaction, cooperation, and conflict resolution (Newcomb & Bagwell, 1995). Through continuous, close interactions with the same friend, children have opportunities to receive feedback from the friend and adjust problematic behaviors, which could improve their peer functioning. Another potential mechanism is via the stress-buffering effects of emotional support. Reciprocated friendship provides a unique affection, loyalty, and alliance, that other peer relationships do not offer (Newcomb & Bagwell, 1995). This sense of companionship and support from friends might help children with higher ADHD symptoms to cope better with stressful peer experiences, such as peer rejection or victimization, rather than displaying aggressive behaviors or social withdrawal.

Interestingly, the presence of unchosen friendships attenuated the associations between fall ADHD symptoms and fewer reciprocated friends, as well as more non-friends, in spring. In this way, unchosen friendship (where the peer nominates the child as a friend but the child does not return the nomination) operated like reciprocated friendship in its protective effects. However, unlike the findings for reciprocated friends, the number of unchosen friends did not buffer the association between ADHD symptoms and self-perceptions of peer support. Thus, being viewed by a peer as a friend may have sociometric benefits for children. However, potentially only reciprocated friendship confers emotional benefits.

It was also intriguing that the presence of unreciprocated friendships accentuated the association between fall ADHD symptoms and poorer sociometric outcomes (fewer reciprocated friends and more non-friends) in spring. Although these findings require replication, it is possible that a pattern of perceiving many peers as friends (who do not share this perception) reflects positive bias. Interestingly, positive bias has been suggested to predict increasing peer relationship problems over time among children with ADHD (Jia et al., 2016). This may be because children with positive bias lack motivation to change their negative social behaviors because they do not perceive themselves to have social difficulties (Owens et al., 2007). It has also been proposed that the lack of awareness about one's negative social impact on others may specifically be off-putting to peers (Jia et al., 2016). Alternatively, such positive bias may stem from cognitive deficits related to the ability to accurately perceive one's own social competency based on feedback from the environment (Owens et al., 2007). Potentially, these cognitive deficits could drive both positive bias and worsening peer problems over time.

Study Strengths, Limitations, and Future Directions

A strength of our study is the use of multiple methods and informants. Sociometric interviews assessed friendship and social preference, children self-reported on victimization and support, and teachers provided ADHD symptom ratings. This reduces concerns about shared method variance driving results. The sociometric method also allowed us to distinguish between reciprocated and unilateral friendship patterns to comprehensively characterize friendship. Another strength is the longitudinal design of the study,

even if short-term, whereby children's functioning in the fall was entered as a statistical control when predicting spring functioning.

We also note several limitations of this study. First, our sample consisted of students in general education classrooms, which increases the applicability of our findings to children with a range of ADHD symptom severity. However, this limits generalizability to clinical samples of children diagnosed with ADHD. We found few differences when inattentive and hyperactive/impulsive symptoms were tested separately in models, but the lack of differences may be attributable to our use of a community sample, where ratings of the two symptom domains were highly correlated. In addition, this study relied upon teacher ratings of ADHD symptoms. Although teacher ratings are most relevant given that this study examined the social experiences of children at school, including parent reports of ADHD symptoms would document that symptoms occur across contexts and would be needed for a diagnosis of ADHD. ADHD symptom ratings may also be correlated with, or better explained by, other mental health conditions that overlap with ADHD, such as anxiety; such comorbidities may also affect the associations between children's ADHD symptoms and peer functioning (Gardner & Gerdes, 2015). We did not assess symptoms of other clinical disorders, and therefore we could not control for these comorbidities in our analyses.

Second, despite the longitudinal design, this study is limited to draw conclusions about causal mechanisms between variables. Based on our significant moderation results, we inferred that reciprocated friends may buffer the negative effects of ADHD symptoms on peer outcomes. However, it may also be that children who formed more reciprocated friendships in fall are those who possess better social skills, which might be the actual moderator of the relationship between ADHD symptoms and future peer outcomes. Further, although our findings were statistically significant, the effect size (as indicated by incremental variance explained) of each finding was relatively small. Yet, it is possible that small incremental increases in social problems associated with ADHD symptoms each school year can add up over time, making it important if reciprocated friendships can prevent these increases.

Third, teachers in the current study had agreed to take part in a trial of a classroom intervention to address the academic and social problems of children with ADHD symptoms. Although intervention condition did not impact any of the outcomes in the current study, it is possible that teachers who volunteered for the study were more open to facilitating the friendships and peer relationships of children with ADHD symptoms. Relatedly, another limitation is that not all students consented to participate. Therefore, sociometric measures were obtained from consented children only, who do not represent the whole classroom. The accuracy of our friendship measures may have been influenced by participation rate in each classroom.

Finally, the current study only considered the number of friends. Future research should also test friendship quality and characteristics of friends, to understand multi-faceted dimensions of friendship (Hartup & Stevens, 1999). These other aspects of friendship may influence children's adjustment (e.g., Becker et al., 2013), and are also impaired in children with symptoms or diagnoses of ADHD (e.g., Marton et al., 2015; Normand et al., 2013).

Clinical Implications

Our findings may carry implications for practitioners and educators who work to foster the peer relationships of children with ADHD symptoms. First, these results underscore the substantial peer difficulties associated with ADHD symptoms, that broadly extend to friendship, social preference, peer support, and peer victimization. Of concern, these peer problems associated with ADHD symptoms seemed to increase over the course of the school year.

Second, our results suggest that it might be useful for clinicians to pay special attention to friendships. Asking children about their own friendships may provide limited information, because ADHD symptoms were associated with a pattern of children giving friendship nominations that were not reciprocated. Nonetheless, children with more reciprocated friends (as validated by sociometric measures) did not experience the same prospective associations between ADHD symptoms and peer problems over the school year. Although our findings do not indicate a clear cutoff required to establish a protective effect of friendship, they suggest that the associations of ADHD symptoms with negative peer outcomes may go away when children have have two reciprocated friends in their classroom (or, a similar number of friends as the typical child) and may even reverse in direction when having four or more reciprocated friends. Perhaps, if interventions can successfully foster friendship in ADHD populations (see Mikami, Normand, et al., 2020 for a potential example), such friendships could buffer the peer difficulties commonly found in children with ADHD symptoms.

The findings that unchosen friendships also buffered against social problems (to a lesser extent), but unreciprocated friendships may exacerbate problems, also suggests the importance of measuring peers' perceptions, not just the perceptions of children with ADHD symptoms. Although in clinical practice it is usually difficult to collect sociometric measures, clinicians might ask parents or teachers to validate children's self-reported friendships, as in Marton et al. (2015).

It also potentially underscores that interventions need to address peers' perceptions or involve peers, to yield maximum utility.

Conclusion

Children's ADHD symptoms may be associated with friendship patterns characterized by fewer unchosen and reciprocated friends and, instead, more non-friends and unreciprocated friends in their classroom. Although children with higher ADHD symptoms tend to experience greater peer relationship difficulties over time, having reciprocated friends can possibly mitigate such negative peer outcomes. Our findings call for the development and validation of interventions targeted to promote dyadic friendship in ADHD populations that may have positive spreading effects on other aspects of peer functioning.

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Compliance with Ethical Standard

Conflict of Interest All authors declare that they have no conflicts of interest.

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