Published in final edited form as:

J Abnorm Child Psychol. 2013 May ; 41(4): 613–625. doi:10.1007/s10802-012-9702-z.

A Longitudinal Assessment of the Associations Among Response Access, Attention Problems, and Aggression during Childhood

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Abstract

Children with ADHD symptoms often display social competence deficits, yet mechanisms for their social difficulties remain unclear. Using data from the normative sample of non-intervention respondents ($N=387$; 50 % male; 49 % non-European-American; age at initial assessment: $M=6.5$ years, $SD=0.48$) in the Fast Track project (Lochman and CPPRG Journal of Consulting and Clinical Psychology 63:549–59, 1995), the social-information processing ability of accessing responses for social situations was modeled across four time points from kindergarten to third grade. Teacher-rated aggression and ADHD symptoms were included as predictors of the intercept and slope. Low ADHD symptoms were associated with a decline in aggressive responses across childhood, whereas high ADHD symptoms were linked to an increase in aggressive responses that decelerated between second and third grade. Regarding competent responses, low ADHD symptoms predicted increases in competent responses, but this increase decelerated between second and third grade. High ADHD symptoms were also associated with a slight increase in competent responses into first grade, but competent responses decreased from first to third grade. Neither aggression nor the interaction of ADHD symptoms and aggression accounted for a significant amount of variance in aggressive or competent responses. Future research should identify if differences in response access associated with high and low ADHD symptoms link to difficulties making and keeping friendships.

Keywords

Social competence; ADHD symptoms; Aggression; Longitudinal

Research has linked social information processing (SIP) deficits with the social competence problems associated with aggression and Attention Deficit/Hyperactivity Disorder (ADHD) symptoms (Matthys et al. 1999). However, it is not clear if ADHD symptoms affect response access, a component of SIP (Crick and Dodge 1994), independent from aggression or if aggression moderates the association between ADHD symptoms and response access. For example, nearly 43 % of children with ADHD symptoms aged 7 to 16 years maintain

high, stable rates of aggression (Jester et al. 2005), and aggression is a strong predictor of social competence deficits for children with ADHD symptoms (Lee and Hinshaw 2004; Zalecki and Hinshaw 2004). If ADHD symptoms independently contribute to response access, improving the effectiveness of the responses that children with ADHD symptoms consider may boost their social competence.

Social Information Processing

SIP is a group of cognitive processes, such as response access, that are associated with evaluating one's environment to identify social behavior that will serve one's objectives (Crick and Dodge 1994). Extensive research has linked aggressive behavior in childhood to deficits in each SIP cognitive process, including encoding social cues, generating attributions, developing goals, identifying potential responses, selecting a response, and enacting it (Camodeca et al. 2002; Crick and Dodge 1994; Lansford et al. 2010). Response access refers to the number and quality of behavioral reactions a child can identify for a specific social situation. Accessing a greater number of aggressive responses is linked to aggression (De Castro et al. 2005; Dodge et al. 1997), but no research has identified the degree to which aggression is related to the number of competent responses accessed.

ADHD symptoms may also leave children vulnerable to response access deficits. Children with ADHD symptoms display other social competence deficits, such as missing social cues and making inaccurate inferences about social situations (Flory et al. 2006). Failing to encode appropriate social cues and making inaccurate inferences may lead to accessing a limited array of competent responses. In addition, children with ADHD symptoms may impulsively abandon or become distracted from generating multiple responses to a situation (Barkley 2006), leaving them fewer options to evaluate before reacting to the situation. This research suggests that ADHD symptoms may independently contribute to response access deficits.

However, the strong links between aggression and ADHD symptoms and aggression and SIP deficits suggest that aggression may moderate the association between ADHD symptoms and SIP deficits, such as response access. Aggression is a common behavioral problem for children with ADHD symptoms with nearly half of children with ADHD symptoms also displaying aggressive behavior (Jester et al. 2005; Waschbusch et al. 1998). Aggression is consistently a strong predictor of social rejection for children with ADHD symptoms (Erhardt and Hinshaw 1994; Lee and Hinshaw 2004), a finding that holds for both genders (Zalecki and Hinshaw 2004; Lee and Hinshaw 2004). Impulsivity and distractibility may lead children with ADHD symptoms to display SIP deficits, which increase the probability of aggressive behavior. Thus, SIP deficits may contribute to the strong link between ADHD symptoms and aggression. If SIP deficits primarily result in social behavior that is aggressive, it is likely that ADHD symptoms would primarily influence the development of SIP deficits, like response access, when aggression is also present. As a result, aggression may moderate the association between ADHD symptoms and response access.

Aggressive and Competent Response Access

We identified three studies that have evaluated the link between ADHD symptoms and aggressive response access and the moderating role of aggression, although all three studies used Oppositional Defiant Disorder (ODD) and/or Conduct Disorder (CD) as a measure of aggression. Matthys and colleagues (1999) considered differences in aggressive response access among boys aged 7 to 12 years with no psychiatric diagnosis, ADHD, ODD/CD, or both ADHD and ODD/CD diagnosis. Children in all three externalizing groups retrieved fewer responses with more responses being aggressive compared to the control group;

however, the externalizing groups did not significantly differ from one another. Thurber et al. (2002) found that girls aged 6 to 12 years with ADHD accessed more aggressive responses than comparisons, but Mikami et al. (2008) with girls aged 6 to 12 years did not support this link. Primary analyses for both studies did not include aggression, although follow-up analyses for both studies revealed that aggressive response access did not significantly differ between children with only ADHD and those with ADHD and ODD.

Results of these studies provide inconsistent findings regarding the unique contribution of ADHD symptoms and aggression to aggressive response access. There may be several reasons for these inconsistencies. First, aggression was measured with ODD/CD in each of the three studies. Although aggressive behavior is a prominent component of both ODD and CD, these diagnoses may differ from aggression. Several studies demonstrate moderate to high correlations between aggression and both ODD and CD (Keenan et al. 2008). Further, Waschbusch and colleagues (1998) found that 88 % of children and adolescents who met criteria for ODD or CD also displayed clinically significant aggression symptoms, whereas only 3 % of those who did not meet criteria for ODD or CD had clinically significant aggression. Although aggressive acts, such as getting into physical fights, are prevalent features of both ODD and CD (Loeber et al. 1991), these diagnoses represent constructs broader than aggression. ODD includes negativistic social interactions, whereas CD symptoms include persistent violation of societal norms and rules (American Psychiatric Association 2000). Thus, the use of ODD/CD limits the degree to which results from these studies can inform our understanding of the role “pure” aggression plays in the relation between ADHD symptoms and response access.

Second, the use of diagnoses rather than symptom dimensions could make unclear the links among aggressive response access, aggressive behavior, and ADHD symptoms. The assumption behind using diagnoses is that the symptom severity cut-point for diagnosis is the same cut-point at which symptoms begin contributing to response access deficits. However, the level of symptom severity at which the association that aggression and ADHD symptoms have with response access begins to contribute to social impairment may be above or below the cut point at which symptoms become clinically significant. If these cut point differ, simply comparing children with and without ADHD diagnosis could result in null findings since both groups would contain children with response access deficits (Keselman et al. 1998; MacCallum et al. 2002). Allowing aggression and ADHD symptoms to remain continuous symptom dimensions avoids this methodological problem, because continuous symptom dimensions permit these associations to be considered across the full range of aggression, ADHD symptoms, and response access. Thus, use of continuous dimensions increases the possibility of detecting significant effects if they are present.

Children with ADHD symptoms may also access fewer competent social responses than peers. Thurber et al. (2002) found that children with ADHD accessed fewer negotiation responses than comparisons when asked how to resolve a conflict with a friend. Similarly, Mikami and colleagues (2008) found that children with ADHD accessed more ineffective responses (i.e., non-aggressive responses unlikely to result in a positive resolution) than peers. Results for both studies remained statistically significant when ODD was controlled for.

Although both studies provide consistent findings, only a diagnosis of ODD was used to approximate aggression and results regarding competent response access for children with both ADHD and ODD were not reported. This methodology leaves unclear the effect of aggressive behavior on competent response access. Further, the use of diagnoses rather than symptom severity also leaves the links among competent response access and ADHD symptoms and aggression unclear.

Methodological Considerations

Several methodological characteristics of previous research limit the field's understanding of how response access develops. First, most samples in SIP research have not included children under the age of seven, yet it is not clear when a propensity for generating aggressive rather than competent responses develops. Although past research has focused on significant differences in SIP abilities based on externalizing disorders, considering when children begin to display SIP deficits is also important. Second, no research exists on the developmental trajectory of any SIP deficits, including aggressive and competent response access. Further, it is unclear how ADHD symptoms and aggression affect the growth and development of aggressive and competent response access over time. Identifying trajectories of social response access and the effect of ADHD symptoms and aggression on these trajectories will clarify the processes that contribute to the development of these social competence deficits.

Also, ADHD symptoms and aggression have typically been conceptualized as categorical rather than continuous variables in research conducted on response access, yet both constructs appear to have the strongest validity and reliability when conceptualized as continuous variables (Frazier et al. 2007; Marcus and Barry 2010; Walton et al. 2011). Reduced variability from dividing a continuous dimension into groups also reduces power to identify significant effects and could result in inaccurate, non-significant associations among ADHD symptoms, aggression, and deficit areas (Keselman et al. 1998; MacCallum et al. 2002). Thus, use of continuous symptom dimensions may improve the precision in evaluating links among ADHD symptoms, aggression, and response access.

We also used data from a normative sample of children, which allowed for the representation of ADHD symptoms and aggression across the full range of symptom severity typical for children. Using a normative sample suggests that the distribution of ADHD symptoms and aggression may correspond more closely to symptom severity in the general child population, increasing the generalizability of results. We also chose to end the response access trajectories at third grade to focus on the contribution of ADHD symptoms and aggression early in the development of response access skills. Finally, we focused exclusively on response access rather than all social information processes, because ADHD symptoms do not appear to be related to each area of SIP. For example, Matthys and colleagues (1999) found that ADHD was independently related to social cue encoding and response access but not efficacy to enact aggressive responses. SIP areas require different cognitive skills that develop at different rates, which likely contribute to variations in developmental trajectories across SIP areas.

The Current Study

The current study investigated two questions. First, we examined whether ADHD symptoms, aggression, or their interaction predicted the development and average level (i.e., slope and intercept) of aggressive response access from kindergarten through third grade. We expected that ADHD symptoms and aggression would independently predict positive growth and a higher average rate of aggressive responses. We also expected that, as both ADHD symptoms and aggression increased, the rate of aggressive responses would increase more than for increases in either ADHD symptoms or aggression alone.

Second, we investigated if ADHD symptoms, aggression, or their interaction predicted the development and the average level of competent response access. We expected that both aggression and ADHD symptoms would predict a lower average rate and a decreased rate of growth for competent responses. We also expected that, as both ADHD symptoms and

aggression increased, the average rate for competent responses would be lower and the rate of growth slower than for increases in either ADHD symptoms or aggression alone.

Methods

Participants

The 387 children who participated in this study were members of the “normative” subsample of the Fast Track project, a longitudinal investigation of the development and prevention of conduct problems in children [Conduct Problems Prevention Research Group (CPPRG) 1992]. High-risk schools were selected based on crime reports and poverty levels and randomly assigned to intervention or control conditions at four sites (Durham, NC; Nashville, TN; Seattle, WA; rural, central PA). Using stratified sampling in non-intervention schools, children were selected for the normative sample during kindergarten to be representative of the school population in behavior problems. Behavior problems were measured with classroom observations (i.e., Teacher Observation of Classroom Adaption—Revised; Werthamer-Larsson et al. 1991) during the winter of participants’ kindergarten year.

Thirty-five percent of participants had single parents and 23 % had mothers without a high school diploma. The sample was 50 % male and 43 % African American, 51 % European American (EA), and 6 % other (parents completed a single question regarding their race and ethnicity). Participant mean age at initial assessment was approximately 6.5 years ($SD=0.48$). The primary language of the home was not assessed. In analyses, for sex, “0” denoted male and “1” denoted female. For race, “0” denoted EA and “1” denoted non-EA participants (a convention used in most Fast Track investigations where race and ethnicity are not constructs of specific interest). Site was coded as a categorical variable; each site received a value from “0” to “4”. Socio-economic status (SES) was diverse and was represented using the Hollingshead (1975) method.

Procedures

Annual assessments were conducted with teachers during the spring and with parents and children during the summer beginning in their kindergarten year. Analyses in this study included data from four assessments from kindergarten through third grade, although assessment for the overall study continued past grade 12. Parents reported demographic data; all other data used in this study were teacher report and child self-report. Teacher reports of the participant’s ADHD symptoms and aggression and child self-report of social response access were used.

Measures

The measures used are described in detail at <http://www.fasttrackproject.org>. Principal constructs in this study were ADHD symptoms, aggression, and social response access.

Aggression and ADHD Symptoms—The kindergarten teacher of each participating child completed the Teacher Report Form (TRF) of the Child Behavior Checklist (CBCL; Achenbach 1991) during the spring of the child’s kindergarten year. This 112-item measure has been used in numerous studies to assess mental health symptoms. Teachers rated each item with 0 being “not true,” 1 “somewhat or sometimes true,” and 2 “very true or often true”; a computer program used a proprietary algorithm to create T-scores for scales and subscales (Rains 2003). Raw score values for two subscales, Aggression and Attention Problems, were used. Regarding the Aggression subscale, 19 items for boys and 20 items for girls were used to construct this scale with scores ranging from 0 to 46; 9.3 % of children had Aggression t-scores above 70. Attention Problems included 9 items for boys and 11

items for girls. Although the subscale is titled “Attention Problems”, the scale actually contains items representing both hyperactivity/impulsivity and inattention symptoms. Specifically, three items for boys and four items for girls corresponded to hyperactivity/impulsivity symptoms (e.g., “Can’t sit still”, “Impulsive/acts without thinking”). Four items for boys and five items for girls corresponded to inattention symptoms (e.g., “Daydreams/gets lost in thoughts”, “Can’t concentrate”). Of the remaining items, one item pertained to “poor school work” and the other item asked about “nervous, high-strung, or tense” behavior. Academic difficulties represent a common impairment area for children with ADHD symptoms (Langberg et al. 2011), whereas hyperactivity/impulsivity can present as “high-strung” or “tense” behavior (Whalen and Henker 1992). Responses ranged from 0 to 36; 9.0 % of children had t-scores above 70 and 15.8 % had t-scores above 65 (at-score of 65 is the advised clinical cut-off for this scale; see Chen et al. 1994). According to Achenbach (1991), test-retest reliability (Attention Problems: $r=0.96$; Aggression: $r=0.91$), and agreement among teachers is satisfactory (Attention Problems: $r=0.61$; Aggression: $r=0.68$). Internal consistency estimates for these data were also strong (Attention Problems: range: 0.90–0.85; Aggression: range: 0.94–0.95; Rains 2003). Research findings support the concurrent and discriminant validity of these scales (Achenbach 1991).

We chose to use teacher report of aggression and ADHD symptoms rather than parent report given research findings suggesting that teachers rate child behavioral symptoms more accurately than parents (Tripp et al. 2006; Owens et al. 2011). We refer to teacher report on the Attention Problems scale as ADHD symptoms.

Response Access—During a home interview, children completed the Social Problem Solving Scale, which was adapted from other instruments (e.g., Dodge et al. 1990), and used to measure response access. After 4 weeks of training and achieving reliability with the trainer, interviewers collected data in the summer after the school year ended. Upon viewing eight picture vignettes of four ambiguous peer provocation situations and four peer group entry situations, children gave three responses to resolve the situation. For example, if the picture showed a child stealing another child’s turn in a game, participants were asked for three ways in which they could get back their turn. Responses were immediately coded.

Interviewers coded responses as aggressive, authority-punish, authority/intervene, irrelevant/other, or competent. Only aggressive, authority-punish, and competent responses were used in analyses. Aggressive and authority-punish responses were combined to represent aggressive responses, given that authority-punish responses may be passive yet thoughtful strategies for being aggressive towards a peer, which may indicate proactive aggression (see Dodge et al. 2002 for more information about these procedures). Aggressive responses included any type of threat or physical or verbal aggression. Authority-punish responses referred to any attempt to seek out an authority figure for punishment of the peer. For example, if a peer stole a child’s turn in a game, the provoked child might tell a teacher and ask that the peer be punished. Competent responses demonstrated a “direct, socially appropriate way of handling the situation..., [e.g.,] asking, making deals, bribing, assertively telling, sharing, trading, and joining in” (Corrigan 2003). To establish inter-rater reliability, a master rater independently coded 25 randomly selected protocols from each site ($r=0.91$, $p<0.01$; Dodge et al. 2002). Aggressive and competent responses were scaled as proportions of total responses accessed; proportions ranged from 0 to 1.0 for competent responses and 0.01 to 0.97 for aggressive responses. Internal consistency was moderate, with coefficient ranging from 0.65 to 0.73 for aggressive responses and 0.63 to 0.74 for competent responses. Test-retest reliability has not been established. Insufficient reliability and variability existed for other response categories to allow for current analyses.

Analytic Procedures

PROC MIXED was used in SAS 9.21 (SAS Institute, Inc., Cary, NC) with full maximum likelihood estimation to analyze a growth model with aggressive responses and another with competent responses. ADHD symptoms, aggression, and the interaction of ADHD symptoms and aggression were included as predictors of the change in response access across time points (e.g., slope) and the average level of response access (e.g., intercept). We included as covariates variables that were significantly related to response access at one or more time points. Thus, we retained participants' sex, SES, and race, but not cognitive ability. Although data collection site was a covariate of the intercept, it was eliminated as a predictor of the slope; models could not converge on a solution with it present, and site was not significantly related to the slope.

Models had two levels. Level one represented four time points (i.e., kindergarten, first grade, second grade, third grade) across which aggressive and competent response access were measured. Level two represented individuals within whom scores for time points were nested. Time was coded with grand mean centering (Raudenbush and Bryk 2002).

Model development for both response types began with the unconditional means model. Fixed and random effects for the linear slope were added and then these effects were added for the quadratic slope to test the presence of a quadratic trend. Inclusion of both slopes was based on the difference between likelihood ratio chi-square values of nested models and statistical significance of the random effects. Finally, the hypothesized predictors (i.e., ADHD symptoms, aggression, their interaction) and covariates were added to account for variance in the random effects. Aggression and ADHD symptoms were centered prior to the creation of the interaction term (Cohen et al. 2003). The equations for the models can be found below, where π_{0i} refers to the intercept or average level of response access, π_{1i} refers to the slope in response access across childhood, and π_{2i} refers to the quadratic slope.

Level 1:

$$Y_{ij} = \pi_{0i} + \pi_{1i}(\text{time}) + \pi_{2i}(\text{time}^2) + \varepsilon_{ij}, \text{ where } \varepsilon_{ij} \sim N(0, \sigma_\varepsilon^2) \quad (1)$$

Level 2:

$$\begin{aligned} \pi_{0i} &= \gamma_{00} + \gamma_{01}(\text{Sex}) + \gamma_{02}(\text{SES}) + \gamma_{03}(\text{Race}) + \gamma_{04}(\text{ADHDSymptoms}) + \gamma_{05}(\text{Aggression}) + \gamma_{06}(\text{ADHDSymptoms} \times \text{Aggression}) - \\ \pi_{1i} &= \gamma_{10} + \gamma_{11}(\text{Sex}) + \gamma_{12}(\text{SES}) + \gamma_{13}(\text{Race}) + \gamma_{14}(\text{ADHDSymptoms}) + \gamma_{15}(\text{Aggression}) + \gamma_{16}(\text{ADHDSymptoms} \times \text{Aggression}) - \\ \pi_{2i} &= \gamma_{20} + \gamma_{21}(\text{Sex}) + \gamma_{22}(\text{SES}) + \gamma_{23}(\text{Race}) + \gamma_{24}(\text{ADHDSymptoms}) + \gamma_{25}(\text{Aggression}) + \gamma_{26}(\text{ADHDSymptoms} \times \text{Aggression}) - \end{aligned} \quad (2)$$

$$\begin{pmatrix} u_{0i} \\ u_{1i} \\ u_{2i} \end{pmatrix} \approx N \left[\begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \tau_{00} & \tau_{01} & \tau_{02} \\ \tau_{10} & \tau_{11} & \tau_{12} \\ \tau_{20} & \tau_{21} & \tau_{22} \end{pmatrix} \right]$$

All data were available from the kindergarten assessment for aggressive and competent responses. However, 6 % of first grade response access data, 8 % of second grade data, and 12 % of third grade data were missing. No data were missing on demographic variables, but 16 % of data were missing from kindergarten teacher-reported aggression and ADHD symptoms. Based on chisquare analyses, missingness for aggression, ADHD symptoms, and aggressive and competent response access at time point 3 was associated with data collection site. No other relations between missingness and the study variables were found. Given that eliminating participants with missing data can create bias (Enders 2010), we used the MI procedure in SAS, which created five complete datasets via multiple imputation with

Monte Carlo simulation using a Markov chain (see Yuan 2000). PROC MIANALYZE provided estimates of descriptive statistics, fixed effects, and variance components across datasets; the model was assessed following procedures stipulated in Enders (2010). This approach allows for sampling variability across imputations, which improves validity of standard errors and estimates (Enders 2010).

With our power estimation, we identified that this sample size was adequate for detection of random effects and simple fixed effects. Our data had at least 80 % power to identify statistical significance for fixed effects if they accounted for at least 1 % of the variance of random effects. Power fell well below 80 % for the interactions.

Results

Prior to estimating growth models, descriptive statistics and correlations (Table 1) were computed for continuous variables. Aggressive responses were skewed for grades 1 through 3 owing to a floor effect, where many participants accessed zero aggressive responses. To evaluate the effects of skew on results, aggressive responses were log transformed, which did not change the shape of the distribution. Thus, we proceeded with analyses using the raw score for aggressive responses. We also evaluated the extent to which competent and aggressive response access as well as aggression and ADHD symptoms were distinct constructs. Competent and aggressive responses were strongly and negatively related from kindergarten to third grade (r s ranged from -0.59 to -0.69 , p s <0.01). Aggression and ADHD symptoms shared a strong positive association ($r=0.61$, $p<0.001$).

Aggressive Response Access

Model development proceeded using the previously-specified approach. Variance components for aggressive response access models are reported in Table 2; Table 3 contains fixed effects. According to the unconditional means model, the grand mean for aggressive responses indicated that, on average across all four time points, 12.2 % of responses that children accessed were aggressive ($\mu=0.122$, $SE=0.004$, $t=28.21$, $p<0.001$). Results of the unconditional linear model showed that the proportion of aggressive responses decreased on average 2.2 % each year ($\beta=-0.022$, $SE=0.003$, $t=-7.87$, $p<0.001$). In addition to significant variance components, the linear slope significantly improved model fit according to the chi-square differences test. The quadratic fixed and random effects also improved fit.

Aggression, ADHD symptoms, and their interaction, along with covariates were then entered into the model (i.e., conditional model). Neither aggression nor its interaction with ADHD symptoms was related to the intercept, linear slope, or quadratic slope. However, ADHD symptoms provided significant prediction of the intercept ($\mu=0.002$, $SE=0.0008$, $t=3.07$, $p=0.003$), slope ($\beta=0.001$, $SE=0.0004$, $t=2.91$, $p=0.0002$), and quadratic slope ($\beta=-0.001$, $SE=0.0004$, $t=-3.11$, $p=0.002$). Figure 1 shows the fixed effect of ADHD symptoms on the intercept, linear slope, and quadratic slope of aggressive responses from kindergarten to third grade. ADHD symptoms are represented with three reference points, one standard deviation below the mean (low ADHD symptoms), the mean (average ADHD symptoms), and one standard deviation above the mean (high ADHD symptoms). These procedures are based on Cohen and colleagues' (2003) recommendations for plotting interactions.

The variance components from the unconditional and conditional model can be compared to identify the proportional variance explained by the predictors (Raudenbush and Bryk 2002). The proportional reduction in variance (i.e., $(\sigma^2_{\text{unconditional}} - \sigma^2_{\text{conditional}}) / \sigma^2_{\text{unconditional}}$) demonstrated that all of the predictors as a set explained 19.5 % of the

variance in the intercept, 11.5 % in the linear slope, and 12.2 % in the quadratic slope of aggressive responses.

Competent Response Access

We conducted identical analyses with competent response access. Variance components for competent responses are presented in Table 2 and fixed effects are reported in Table 4. In the unconditional means model, the grand mean of competent responses indicated that on average across all four time points, 70 % of the behavioral responses that children generated were competent ($\gamma_{00}=0.70$, $SE=0.005$, $t=119.95$, $p<0.001$). Fixed and random effects for the linear slope were added (i.e., unconditional linear model), which indicated that on average there was a 1.7 % increase each year in the proportion of competent responses ($\gamma_{10}=0.017$, $SE=0.004$, $t=4.86$, $p<0.001$). In the unconditional linear model and the unconditional quadratic model, the chi-square difference test, and the significance of variance components supported inclusion of the random and fixed effects of the linear and quadratic slope.

Teacher-rated ADHD symptoms, aggression, their interaction, and covariates were then included (i.e., conditional model). Aggression and the interaction of ADHD symptoms and aggression were not significant predictors of either slope or the intercept. The quadratic fixed effect indicated that competent responses displayed a deceleration in later grades ($\gamma_{20}=-0.029$, $SE=0.005$, $t=-5.80$, $p<0.001$). ADHD symptoms were significantly associated with the average level ($\gamma_{04}=-0.003$, $SE=0.001$, $t=-3.41$, $p<0.001$) and linear slope of competent responses ($\gamma_{14}=-0.002$, $SE=0.001$, $t=-3.45$, $p<0.001$). Figure 2 shows the fixed effect of ADHD symptoms on the intercept, linear slope, and quadratic slope of competent responses from kindergarten to third grade. The graph represents the effect of ADHD symptoms on the development in competent responses with the same procedure outlined by Cohen and colleagues (2003) used for Fig. 1. The proportional reduction in variance indicates that the predictors as a set explained 25.2 % of the variance in the intercept, 11.9 % in the linear slope, and 8.6 % in the quadratic slope of competent responses.

Discussion

The objectives of this study were twofold. Our first goal was to identify whether teacher-reported ADHD symptoms had an effect independent from aggression on the average level and development of aggressive response access from kindergarten to third grade and if aggression moderated that effect. Second, we sought to discern whether teacher-reported ADHD symptoms had an effect independent from aggression on the average level and development of competent response access from kindergarten to third grade, and we assessed the potential moderating role of aggression on that effect. Results indicated that ADHD symptoms predicted the average rate as well as the linear and quadratic slopes of aggressive responses. Low ADHD symptoms were associated with a decline in aggressive responses across childhood, whereas children with high ADHD symptoms displayed an increase in aggressive responses that decelerated between second and third grade. ADHD symptoms also predicted the average rate and linear slope of competent responses. Children with low ADHD symptoms increased in competent response access, which decelerated between second and third grade. Children with high ADHD symptoms also showed a slight increase in competent responses into first grade, but competent responses decreased from first into third grade. Neither aggression nor the interaction of ADHD symptoms and aggression accounted for a significant amount of variance in aggressive or competent responses.

The positive association between ADHD symptoms and the average rate of aggressive response access is consistent with some research (Thurber et al. 2002), but conflicts with other studies (Matthys et al. 1999; Mikami et al. 2008). No previous research exists that

assessed the effect of ADHD symptoms on the rate of growth in aggressive response access. However, the finding that high ADHD symptoms predicted a lower average rate and a decline in competent responses aligns with previous research (Thurber, et al. 2002). Given that previous studies included samples with only girls, our results indicate that ADHD symptoms are associated with differences in competent response access for children of both sexes.

Surprisingly, aggression did not predict the average rate or the change over time in aggressive responses. One explanation may be that response access deficits associated with aggression appear more prominently in adolescence than childhood (Fontaine et al. 2009). Response access may play a larger role in aggression during adolescence than childhood. It is also possible that the emotional context of the situation, including the mood or affective style of the child and peer, may influence SIP (Lemerise and Arsenio 2000). Although children may not access aggressive responses when viewing a vignette of peer provocation, they may access aggressive responses when a peer actually provokes them. Thus, capacity to regulate emotions may impact aggressive response access as well as other areas of SIP (Gower and Crick 2011).

Findings have important implications for the development of social behavior and peer relationships for children with ADHD symptoms. Accessing fewer competent responses indicates that children with high ADHD symptoms may consider fewer competent behavioral responses before responding to peers, which may lead to enacting fewer prosocial behaviors. Prosocial behaviors are important for social status and building friendships during childhood (Newcomb et al. 1993). Thus, further research should evaluate the contribution that accessing fewer competent responses may make to the low peer status that is often linked to ADHD symptoms (Hoza et al. 2005).

Moreover, accessing more aggressive responses than peers provides more opportunity to positively evaluate aggressive behavior, which may lead to enacting more aggressive behavior with peers. Aggression, a strong predictor of peer rejection, may engage children with ADHD symptoms in a cycle that perpetuates SIP deficits, aggressive behavior, and peer rejection. Peer rejection may create cascading effects where peer rejection escalates SIP biases, such as aggressive response access, which in turn contribute to aggressive behavior (Lansford et al. 2010). Thus, peer rejection may help to maintain aggressive response access.

If children with ADHD symptoms can learn to construct competent responses and if aggressive response access is amenable to change, response access may hold potential as an effective intervention target for social competence deficits associated with ADHD symptoms. Several efficacious treatments have been developed that demonstrated changes in SIP style and reductions in aggressive behavior. For example, the Anger Coping Program is an intervention that targets aggression and includes components that address social information processes related to aggression (Lochman et al. 2006). Outcomes for this intervention have demonstrated strong effects, which show that SIP style can change. Although further research is necessary to establish these links for ADHD symptoms and response access, flexibility in SIP style suggests that improved response access may improve social functioning for children with ADHD symptoms.

It is unclear why children with high ADHD symptoms accessed more aggressive and fewer competent responses than peers. It is possible that inattentive, hyperactive, or impulsive symptoms, or a combination of these symptoms, may influence other deficits in social competence associated with ADHD symptoms that together compound deficits in response access. Distraction and overactivity may lead to encoding fewer social cues than peers (Flory et al. 2006). Forgetfulness and distractibility may lead to failing to use social cues to

make accurate inferences about one's social environment (Flory et al. 2006). Identifying viable social responses may not be possible without encoding the social cues that signal the appropriate social response or using social cues to make accurate inferences about the situation. Even if children with ADHD symptoms access effective solutions for social problems, impulsive decision-making may lead to the selection of the first available response (Barkley 2006), shortchanging evaluation of potential outcomes for behavioral responses. Thus, identifying how response access relates to other social-cognitive skills will aid understanding of the social competence deficits associated with ADHD symptoms.

A goal for future research is also identifying how the average rate and growth in ADHD symptoms affect response access. Our study assessed only how kindergarten ADHD symptoms affect the development of response access. However, the developmental trajectories of inattention and hyperactivity/impulsivity at later ages may also affect aggressive and competent response access. For example, as hyperactivity increases during childhood, the proportion of aggressive responses a child accesses may increase even more than these results indicate. On the other hand, many studies on developmental trajectories of ADHD symptoms indicate that, for some children, symptoms subside throughout childhood (Malone et al. 2010; Jester et al. 2005; Shaw et al. 2005). However, these studies suggest that even ADHD symptoms that resolve or subside may create long term decrements in skills related to social functioning, such as social response access.

Limitations

Several issues limit the generalizability of these findings. The fixed effect of ADHD symptoms on response access was quite small, potentially limiting the clinical significance of findings. Other variables may have influenced the development of response access. For example, ADHD symptoms later in childhood than kindergarten may also affect the development of response access. Assessing response access with vignettes may have limited the ecological validity of these data and contributed to small effect sizes. Some research indicates that measuring behavior outside of the emotional context in which it occurs can reduce the validity of responses (see Robinson and Clore 2002 for review of emotional memory). Emotional arousal, present when actually experiencing the situations in the vignettes but not when viewing the vignettes, may shape behavioral decision-making (Lemerise and Arsenio 2000). Using more naturalistic methodology than social vignettes in future research may improve validity of data.

Teacher report on the Attention Problems subscale does not include all DSM-IV (APA 2000) criteria for ADHD symptoms, even though scores on the Attention Problems subscale and ADHD symptoms according to the DSM-IV are substantially overlapping constructs. Attention Problems scores and ADHD symptoms are moderately to highly correlated (Achenbach and Rescorla 2001), and the Attention Problems scale highly correlates with both inattention and hyperactivity on the Conners Teacher Rating Scale (Conners 1989), a frequently used measure of ADHD symptoms (Achenbach 1991). Further, clinically significant teacher reported symptoms on the Attention Problems subscale correspond with DSM-IV ADHD diagnoses identified through clinical interview with caregivers (Chen et al. 1994; Derks et al. 2006). Given that research indicates that teacher reported attention problems correspond with an ADHD diagnosis (Derks et al. 2006), the use of the TRF is considered an evidence-based, valid method for identifying ADHD symptoms (Pelham et al. 2005). Further, precedent exists for using this scale to represent ADHD symptoms in research (Breslau et al. 2010; Robbers et al. 2011). Results should be replicated with more comprehensive measurement of ADHD symptoms, but correspondence between our measure and ADHD symptoms measured in other ways supports generalization of our results to children with ADHD symptoms.

Although use of symptom dimensions does not permit detection of differences based on ADHD diagnosis, it provides a more accurate representation of ADHD symptoms. As discussed previously in the introduction, because ADHD symptoms occur on a continuum of symptom severity, they are better conceptualized as a continuous rather categorical variable (Frazier et al. 2007; Marcus and Barry 2010). Thus, use of ADHD symptoms as continuous rather than categorical avoids many of the statistical limitations associated with cutting up a continuous variable (Keselman et al. 1998; MacCallum et al. 2002).

The combination of symptom dimensions and use of a normative sample may make unclear to whom these results generalize. Our sample had slightly higher rates of clinical levels of ADHD symptoms (i.e., t-score >65; 15.8 %) than the prevalence rate of ADHD diagnosis (5–10 %; Barkley 2006). In our analyses probing significant interactions, high ADHD symptoms (symptoms one standard deviation above the mean) corresponded to a t-score of 63, which was close to the clinical cut-off. This close correspondence suggests that it may be possible to use these findings to make inferences about the link between ADHD diagnosis and response access. However, future research should identify the level of symptoms at which ADHD contributes to changes in response access that affect social interaction.

Also, owing to a floor effect, the distribution for aggressive responses at all four time points displayed skew and kurtosis outside cut points that indicate a normal distribution. Given the assumption of regression that residuals of dependent variables are normally distributed, these violations may have affected results. Given the use of a normative sample, the rate of clinically significant aggression and ADHD symptoms in this sample was quite low. The low rate of aggression may also have contributed to the lack of association found between aggression and response access. Finally, given that psychometric properties for the Social Problem Solving Scale have not been adequately evaluated, use of this measure may have limited validity.

Summary and Conclusions

Results demonstrate that ADHD symptoms, over and above aggression, significantly affected the rate and change in aggressive and competent response access. Findings indicated that children with ADHD symptoms consider behavioral options that are likely to result in unsuccessful peer interactions. Future research should consider the effect that response access may have on the social relationships of children with ADHD symptoms.

Acknowledgments

This work was supported by National Institute on Drug Abuse (NIDA) Career Development Award K01 DA024116 to the third author. The Fast Track data have been collected and managed with the support of National Institute of Mental Health (NIMH) grants R18 MH48043, R18 MH50951, R18 MH50952, and R18 MH50953. The Center for Substance Abuse Prevention and NIDA also provided support for Fast Track through a memorandum of agreement with the NIMH. Fast Track work was also supported in part by Department of Education grant S184U30002 and NIMH grants K05MH00797 and K05MH01027.

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Fig. 1. Fixed effects of ADHD symptoms on aggressive responses. The graph includes the fixed effect of ADHD symptoms on the intercept, linear slope and quadratic slope of aggressive responses from kindergarten to third grade. The lines represent the model-implied effects at one standard deviation below the mean (Minus 1 SD), at the mean, and at one standard deviation above the mean (Plus 1 SD) for ADHD symptoms

Fig. 2. Fixed effect of ADHD symptoms on the intercept of competent response access. The graph includes the fixed effect of ADHD symptoms on the intercept, linear slope, and quadratic slope of competent responses from kindergarten to third grade. The lines represent these model-implied effects one standard deviation below the mean (Minus 1 SD), at the mean, and at one standard deviation above the mean (Plus 1 SD) for ADHD symptoms

Table 1

Correlations and descriptive statistics for model variables

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. AGG	1.00									
2. ATT	0.614**									
3. ARGK	0.074	-0.021								
4. ARG1	0.013	0.108	0.155**							
5. ARG2	0.162**	0.230**	0.158**	0.381**						
6. ARG3	0.076	0.155*	0.133**	0.245**	0.321**					
7. CRGK	-0.103*	-0.087	-0.590**	-0.115*	-0.158*	-0.133**				
8. CRG1	-0.088	-0.142*	-0.170*	-0.662**	-0.304**	-0.190**	0.226**			
9. CRG2	-0.197**	-0.304**	-0.169**	-0.249**	-0.686**	-0.225**	0.257**	0.337**		
10. CRG3	-0.069	-0.243**	-0.208**	-0.254	-0.289**	-0.656**	0.247**	0.256**	0.336**	
11. SES	-0.199**	-0.326**	-0.039	0.028	-0.014	0.016	0.096	-0.020	0.070	-0.007
Mean	9.787	10.534	0.158	0.131	0.105	0.105	0.649	0.716	0.733	0.702
Standard	11.45	10.192	0.159	0.129	0.114	0.100	0.210	0.159	0.149	0.152
Deviation										
Skew	1.133	0.615	1.492	1.722	1.669	1.553	-0.512	-0.564	-0.786	-0.343
Kurtosis	0.781	-0.652	2.793	5.384	4.579	4.552	0.164	0.591	1.657	0.049

AGG Aggression, ATT ADHD Symptoms, ARGK Aggressive Response Access in kindergarten, ARG1 Aggressive Response Access in first grade, ARG2 Aggressive Response Access in second grade, ARG3 Aggressive Response Access in third grade, CRGK Competent Response Access in kindergarten, CRG1 Competent Response Access in first grade, CRG2 Competent Response Access in second grade, CRG3 Competent Response Access in third grade, SES Socio-economic status

* $p < 0.05$;

** $p < 0.01$

Table 2

Random effects for multilevel model with aggressive and competent response access

Parameters	Unconditional means model	Unconditional linear model	Unconditional quadratic model	Conditional model
Aggressive Response Access				
Intercept (<i>00</i>)	0.004 (0.004) *	0.004 (0.0005) *	0.006 (0.001) *	0.005 (0.0009) *
Linear Slope (<i>11</i>)	–	0.001 (0.0003) *	0.001 (0.0003) *	0.001 (0.0003) *
Quadratic Slope (<i>22</i>)	–	–	0.001 (0.0003) *	0.001 (0.0003) *
Residual (<i>e_{ij}</i>)	0.013 *	0.011 *	0.010 *	0.010 *
Model Fit Statistics				
Df	1	3	6	6
Chi-Square	90.15 **	49.32 **	33.35 **	30.79 **
Competent Response Access				
Intercept (<i>00</i>)	0.007 (0.001) *	0.001 (0.0001) *	0.007 (0.002) *	0.006 (0.001) *
Linear Slope (<i>11</i>)	–	0.005 (0.001) *	0.002 (0.0005) *	0.002 (0.0005) *
Quadratic Slope (<i>22</i>)	–	–	0.001 (0.0005) *	0.001 (0.0005) *
Residual (<i>e_{ij}</i>)	0.060 *	0.057 *	0.017 *	0.017 *
Model Fit Statistics				
Df	1	3	6	6
Chi-Square	91.01 **	40.83 **	28.67 **	24.90 **

Degrees of freedom correspond to the number of freely estimated parameters. Chi-square values were calculated using the procedure outlined by Li et al. (1991)

*
 $p < 0.01$

**
 $p < 0.001$

Table 3

Fixed effects of multilevel model with aggressive response access

Parameters	Unconditional means model	Unconditional linear model	Unconditional quadratic model	Conditional model
Intercept (₀₀)	0.122 (0.004) **	0.122 (0.004) **	0.117 (0.006) **	0.115 (0.013) **
Linear Slope (₁₀)	–	–0.022 (0.003) **	–0.022 (0.003) **	–0.022 (0.003) **
Quadratic Slope (₂₀)	–	–	0.004 (0.003)	0.006 (0.004)
Sex				
Intercept (₀₁)				–0.021 (0.011)
Linear Slope (₁₁)				0.006 (0.006)
Quadratic Slope (₂₁)				0.002 (0.006)
SES				
Intercept (₀₂)				0.0004 (0.0005)
Slope (₁₂)				0.0004 (0.0002)
Quadratic Slope (₂₂)				–0.0003 (0.0003)
Race				
Intercept (₀₃)				0.006 (0.014)
Slope (₁₃)				–0.001 (0.006)
Quadratic Slope (₂₃)				0.003 (0.006)
ADHD Symptoms				
Intercept (₀₄)				0.002 (0.001) **
Slope (₁₄)				0.001 (0.0004) **
Quadratic Slope (₂₄)				–0.001 (0.0004) **
Aggression				
Intercept (₀₅)				–0.001 (0.001)
Slope (₁₅)				–0.001 (0.0004)
Quadratic Slope (₂₀)				0.001 (0.0004)
ADHD Symptoms x Aggression				
Intercept (₀₆)				0.000 (0.000)
Linear Slope (₁₆)				0.000 (0.000)
Quadratic Slope (₂₀)				0.000 (0.000)

Data collection site was also a predictor of the intercept, but was not reported above. Sex was coded as 0="male" and 1="female". Socio-economic status (SES) was represented using the method devised by Hollingshead (1975). Race was coded as 0="European-American" and 1="Non-European-American"

*
p<0.05

**
p<0.01

Table 4

Fixed effects of multilevel model with competent response access

Parameters	Unconditional means model	Unconditional linear model	Unconditional quadratic model	Conditional model
Intercept (₀₀)	0.700 (0.006) **	0.700 (0.006) **	0.730 (0.007) **	0.729 (0.015) **
Linear Slope (₁₀)	–	0.018 (0.004) **	0.018 (0.004) **	0.017 (0.004) **
Quadratic Slope (₂₀)	–	–	–0.024 (0.004) **	–0.029 (0.005) **
Sex				
Intercept (₀₁)				0.047 (0.014) **
Linear Slope (₁₁)				–0.003 (0.008)
Quadratic Slope (₂₁)				–0.011 (0.008)
SES				
Intercept (₀₂)				–0.0005 (0.001)
Slope (₁₂)				0.001 (0.0003) *
Quadratic Slope (₂₂)				0.000 (0.0003)
Race				
Intercept (₀₃)				0.004 (0.016)
Slope (₁₃)				0.004 (0.008)
Quadratic Slope (₂₃)				–0.006 (0.008)
ADHD Symptoms				
Intercept (₀₄)				–0.003 (0.001) **
Slope (₁₄)				–0.002 (0.0005) **
Quadratic Slope (₂₄)				0.0003 (0.0006)
Aggression				
Intercept (₀₅)				–0.000 (0.001)
Slope (₁₅)				0.001 (0.001)
Quadratic Slope (₂₅)				–0.000 (0.001)
ADHD Symptoms × Aggression				
Intercept (₀₆)				0.000 (0.000)
Linear Slope (₁₆)				0.000 (0.000)
Quadratic Slope (₂₆)				0.000 (0.000)

Data collection site was also a predictor of the intercept, but was not reported above. Coding for sex was 0=“male” and 1=“female”. Socio-economic status (SES) was represented using the method devised by Hollingshead (1975). Race was coded as 0=“European-American” and 1=“Non-European-American”

*
p<0.05

**
p<0.01