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Antisocial Behaviors Moderate the Deviant Peer Pathway to Substance Use in Children With ADHD

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Abstract

This study evaluated the interplay of attention deficit hyperactivity disorder (ADHD) symptom severity, deviant peer group affiliation, oppositional defiant disorder (ODD), and conduct disorder (CD) as risk factors among 142 adolescents with childhood ADHD. Deviant peer affiliation mediated the relation between childhood ADHD symptoms and 6 substance use and abuse variables. Moreover, moderated mediation analyses found that for children with high levels of ODD and CD symptoms, the mediated effect of ADHD through deviant peer affiliation was significant; however, for children with low levels of ODD and CD symptoms, this mediated effect was weak and nonsignificant. Results suggest that children with severe ADHD symptomatology and comorbid antisocial behavior are at highest risk for peer-mediated substance use in adolescence.

Attention deficit hyperactivity disorder (ADHD) is a persistent and pervasive mental health problem that first appears in childhood and is comprised of two primary symptom domains, inattention and hyperactivity–impulsivity (American Psychiatric Association, 1994). Several decades of research have shown that childhood ADHD is associated with diminished academic, behavioral, and social functioning in adolescence (see Mannuzza & Klein, 1999). For example, longitudinal studies show that children diagnosed with ADHD are at higher risk for substance use (e.g., Barkley, Fischer, Edelbrock, & Smallish, 1990; Hartsough & Lambert, 1987; Milberger, Biederman, Faraone, Chen, & Jones, 1997) and substance use disorders (Gittelman, Mannuzza, Shenker, & Bonagura, 1985) than are children without ADHD. A recent article that we published expanded on these previous results (Molina & Pelham, 2003). Using a clinic sample of children with ADHD interviewed later as adolescents ($n = 142$) and a demographically similar comparison group of adolescents with no ADHD ($n = 100$), we found that childhood ADHD predicted adolescent heavy alcohol use and alcohol-related problems, daily cigarette smoking, and marijuana and illicit drug use. These findings indicated that ADHD in childhood is a risk factor for early substance use and abuse in adolescence; however, little is known about why children with ADHD might be at higher risk. In another recent study, we began to examine this research question by showing that deviant peer group affiliation (perceived peer substance use and peer tolerance of other's substance use) was a robust mediator of the relation between ADHD diagnosis in childhood and substance use in adolescence (Marshal, Molina, & Pelham, 2003). Although this is a significant first step in examining pathways to substance use in children with ADHD, many questions remain unanswered. For example, it is not clear which components of ADHD (i.e., inattention symptoms, hyperactivity–impulsivity symptoms, or both) put children at highest risk for deviant peer affiliation or whether children with comorbid antisocial behaviors such as oppositional defiant disorder (ODD) and conduct disorder (CD) are at greater risk for peer-mediated substance use than

children without ODD and CD. The primary goals of this study were to examine these questions.

Deviant peer affiliation was an intuitive place to start examining mediators of the ADHD effect on adolescent substance use because (a) children with ADHD are less successful in the peer-group setting than are children without ADHD (see Henker & Whalen, 1999; Pelham & Bender, 1982; Wheeler & Carlson, 1994); (b) peer rejection is a significant risk factor for affiliating with deviant (antisocial) peers (Dishion, Patterson, Stoolmiller, & Skinner, 1991); and (c) deviant peer affiliation is one of the strongest predictors of adolescent substance use (Hawkins, Catalano, & Miller, 1992) and a central component in most theories of adolescent substance use (Petratis, Flay, & Miller, 1995).

It is important to determine which components of ADHD may be leading to the high rates of deviant peer affiliation and subsequent substance use. Children with high levels of hyperactivity-impulsivity might be vulnerable to a "social failure" pathway to deviancy because they are more likely to be rejected by their peers and as a result more likely to affiliate with peers out of the social mainstream in behavior and attitude. For example, children with hyperactivity-impulsivity are more often voted as "less likable" by their peers as compared to children without these symptoms (Hinshaw & Melnick, 1995; C. Johnston, Pelham, & Murphy, 1985; Pelham & Bender, 1982). Moreover, children with high levels of hyperactivity-impulsivity often engage in impulsive, sensation-seeking behaviors and have difficulties regulating their behavior and emotion during social interactions with other children, both of which can serve as "negative social catalyst(s)" (Whalen & Henker, 1985) in social arenas. Children who are less successful in peer relationships are more likely to develop problems in adolescence (Coie, Terry, Lenox, & Lochman, 1995), including higher level of association with deviant (antisocial) peers (Coie, Terry, Zakriski, & Lochman, 1995; Dishion et al., 1991).

Children with high levels of inattention may also be vulnerable to the social failure pathway to adolescent deviancy. For example, a growing body of evidence suggests that children who have attentional deficits (without hyperactivity) are rated by peers (Carlson, Lahey, Frame, Walker, & Hynd, 1987) and parents (Maedgen & Carlson, 2000) as less likeable than children without ADHD. There is some evidence to suggest that deficits in social knowledge necessary to meet the high social and interpersonal demands of the peer environment may contribute to this effect (Maedgen & Carlson, 2000). In addition, severe inattention can cause academic problems that lead to deviant peer affiliation (i.e., a putative "school failure" pathway to deviancy). For example, among adolescents diagnosed with ADHD in childhood, inattention symptoms were more strongly related to grade point average than were hyperactivity-impulsivity symptoms (Molina, Smith, & Pelham, 2001). Moreover, children with ADHD inattentive type score lower on standardized tests of achievement (particularly math) than do children with ADHD combined type (Hynd et al., 1991; Marshall, Hynd, Handwerk, & Hall, 1997). These school difficulties may be associated with peer deviancy. For example, Dishion et al. (1991) found that academic achievement at age 10 was a significant predictor of deviant peer affiliation (peer antisocial behavior) at age 12, above and beyond peer's and one's own antisocial behavior at age 10, parenting behaviors, and peer rejection.

The first goal of this study, therefore, was to test the hypothesis that childhood inattention and hyperactivity-impulsivity symptoms would account for unique variance in adolescent deviant peer affiliation and that deviant peer affiliation would mediate the effects of each of these predictors on adolescent substance use outcomes. To test these hypotheses, we shifted our focus from a between-group analysis in our previous study, in which we compared ADHD versus controls (Marshall et al., 2003), to a within-group analysis, whereby the unique effects of

childhood inattention and hyperactivity–impulsivity symptoms on deviant peer affiliation within the ADHD group are examined.

The second goal of this study was to determine whether this mediational pathway was affected by the presence of antisocial comorbidity. Determining the best way to conceptualize and test the relations among childhood disruptive behavior disorders and their relation to adolescent and young adult psychopathology is controversial and part of an ongoing epistemological debate in the child psychopathology literature (e.g., see Lynam, 1996; Moffitt, 1993). This is particularly true when attempting to examine pathways of risk from childhood ADHD to adolescent substance use, because ODD and CD are highly comorbid with ADHD and substance use (Burke, Loeber, & Lahey, 2001; Burns & Walsh, 2002; Loeber & Keenan, 1994).

As result, in this study, we tested ODD and CD as potential moderators to determine if children with ADHD who also have high levels of ODD or CD symptoms might be on a different pathway of risk for substance use than children with ADHD only. For example, in our previous study, which found elevated substance use and abuse among children with ADHD, we found that probands who had developed CD by adolescence reported the highest levels of substance use and substance use disorder problems (Molina & Pelham, 2003). Modeling ODD and CD as moderators, therefore, allows for an investigation of different levels or types of risk in children with ADHD (see Lynam, 1996). Indeed, many children with ADHD do not develop antisocial behaviors later in life, and these children may have different risk profiles than those who do.

Based on this background literature, we predict (a) that the relation between childhood ADHD symptoms and deviant peer affiliation will be stronger for children with high levels of ODD and CD symptoms (see interaction *d* in Figure 1) and (b) that the relation between deviant peer affiliation and substance use will be stronger for children with high levels of ODD and CD symptoms (see interaction *e* in Figure 1). In addition, if either of these moderator models is supported, we propose testing the mediated pathway (paths *a* and *b*) at high and low levels of ODD and CD. In doing so we test a moderated mediation model (for other examples and discussion see Baron & Kenny, 1986; Donaldson, 2001; James & Brett, 1984; Morgan-Lopez, Castro, Chassin, MacKinnon, 2003; Tein, Sandler, MacKinnon, & Wolchik, 2004). This modeling paradigm tests the hypothesis that the strength of the mediated effect varies across different levels of a fourth variable. In the context of our deviant peer affiliation model, our hypothesis is that mediation through deviant peer affiliation will be strong for the children with high levels of ODD and CD and weak for children with low levels of ODD and CD.

Method

Participants

Participants in this study were 142 children with ADHD who were interviewed again as 13- to 17-year-old adolescents. Most (142, 88.7%) were between 5 and 12 years old at the time of their assessment for ADHD in childhood. An average of 5.26 years elapsed between the childhood assessment and the follow-up interview in adolescence ($SD = 2.22$ years, range = 0 to 11 years). Their mean age in adolescence was 15.2 years ($SD = 1.4$). Eighty-six percent of the adolescents were Caucasian, 11% were African American, and 3% had other ethnic backgrounds. Most adolescents (94%) were male. Most adolescents (90%) were attending a regular public or private school at the time of the follow-up interview; however, some (9%) were in alternative school settings (e.g., vocational school or an accredited school within a residential treatment facility) and 2 adolescents were interviewed within 6 months after graduating from high school. On average, adolescents had completed 9.4 ($SD = 1.5$) years of school. The majority of these ADHD participants lived in a two-parent household (70%). All

of the parents graduated from high school or received their high school equivalency degree. Forty-five percent graduated from college. The median family income was \$46,000.

Procedure

Childhood—All participants received a Diagnostic and Statistical Manual of Mental Disorders (3rd ed., rev. [*DSM-III-R*]; American Psychiatric Association, 1987) or a Diagnostic and Statistical Manual of Mental Disorders (4th ed. [*DSM-IV*]; American Psychiatric Association, 1994) diagnosis of ADHD in childhood. They received services at the Western Psychiatric Institute and Clinic ADD Program (University of Pittsburgh Medical Center) between the years of 1987 and 1995. At that time parents and teachers completed a packet of intake measures that included the Disruptive Behavior Disorders Scale (Pelham, Gnagy, Greenslade, & Milich, 1992), the IOWA/Abbreviated Conners (Goyette, Conners, & Ulrich, 1978; Loney & Milich, 1982), and the Swanson, Nolan, and Pelham Scale (Atkins, Pelham, & Licht, 1985), which are norm-referenced, standardized paper-and-pencil measures of *DSM-III-R* and *DSM-IV* ADHD symptom criteria and additional externalizing and social behaviors. These teacher and parent ratings of behavior were used to assess the presence or absence of ADHD symptomatology. In addition, a semistructured diagnostic interview (see Pelham et al., 2002) was conducted with parents by doctoral clinicians to confirm presence of *DSM-III-R* or *DSM-IV* ADHD symptoms, assess comorbid problems, and rule out alternative diagnoses. Children were excluded from this follow-up study if their IQ was less than 80 or if they had a seizure disorder, other neurological problems, or a history of pervasive developmental, psychotic, sexual, or organic mental disorders.

Adolescence—Of the contacted eligible children who received services at the ADD Program, 56.5% ($n = 142$) participated in this follow-up study. Despite the modest rate of participation, there were no statistically significant differences between participants and nonparticipants in childhood variables measuring ADHD, ODD, and CD symptoms (in either parent or teacher report of *DSM-IV* or *DSM-III-R* symptoms) or in full-scale IQ or achievement test scores (reading and math). All effect sizes (Cohen's d) were $< .20$ (see Cohen, 1988). These participants and their parents completed a one-time office-based interview for the follow-up study. Confidentiality of information was supported with a Certificate of Confidentiality from the Department of Health and Human Services with certain exceptions (e.g., suicidality, child abuse), and the study protocol was approved by the University of Pittsburgh Institutional Review Board. Following collection of written informed consent from the parents (and assent from the participants) separately, adolescents, mothers, and fathers were interviewed separately. Paper-and-pencil and interview questions were read aloud to adolescents who followed along on their own copy of the measures. Interviewers recorded the answers (substance use was an exception; details are discussed later). At least three teachers of primary academic subjects were also asked to complete ratings of behavior (including ADHD symptomatology) and academic performance. Further details regarding recruitment of the follow-up participants in adolescence may be found elsewhere (Bagwell, Molina, Pelham, & Hoza, 2001; Molina & Pelham, 2003).

Childhood Measures

ADHD, ODD, and CD symptoms—The Disruptive Behavior Disorders Scale (Pelham et al., 1992) was used to assess inattention, hyperactivity-impulsivity, ODD, and CD symptoms. The number of items used for each scale ranged from 5 (*inattention*) to 13 (*CD*). The response scale for each item was 0 (*not at all*), 1 (*just a little*), 2 (*pretty much*), and 3 (*very much*). The highest response (parent vs. teacher) to each item was used for each participant, and the four subscales were created by estimating the mean across items for each scale. Therefore the possible range for each scale was 0 to 3. Cronbach's alphas for these scales ranged from .62 (*inattention*) to .88 (*ODD*).

Adolescent Measures

CD symptoms—Adolescent CD was operationalized as the total number of *DSM-IV* symptoms endorsed by the parent or the child using items from the Diagnostic Interview Schedule for Children 2.3 or 3.0, which is a fully structured diagnostic clinical interview for children and adolescents (Shaffer et al., 1996; Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000). The Diagnostic Interview Schedule for Children was administered by trained bachelor's level staff in face-to-face interviews and later scored by senior project staff.

Deviant peer affiliation—Deviant peer affiliation in adolescence was operationalized as perceived peer substance use (six items) and perceived peer tolerance of adolescent substance use (seven items) adapted by Chassin, Pillow, Curran, Molina, and Barrera (1993) from the Monitoring the Future study (L. Johnston, O'Malley, & Bachman, 1988). Adolescents reported how many of their friends, ranging from 1 (*none*) to 6 (*all*), engaged in six forms of substance use: occasional and regular use of "alcohol," "marijuana or hashish," and "other drugs." Adolescents also rated on a 6-point scale how their close friends would feel if he or she engaged in these same six forms of substance use, as well as "weekend heavy alcohol use," ranging from 1 (*strongly disapprove*) to 5 (*strongly approve*). The correlation between the mean of the peer use items and the mean of the peer tolerance of use items within the probands was fairly strong ($r = .66, p < .0001$), and we did not have theoretical justification for distinguishing between perceived peer use and perceived peer tolerance of use in adolescents with childhood ADHD; therefore, we calculated an overall perceived peer deviancy score by averaging all 13 items (Cronbach's $\alpha = .92$). This overall peer deviancy score was correlated with the mother's report on three single-item, dichotomous measures (yes/no) of her disapproval of the adolescent's friends ($r = .21, p < .05$), her perception that the adolescent's friends were a bad influence ($r = .17, p < .05$), and mother's disapproval of the adolescent's friends' behavior ($r = .15, p < .08$). In this sample, most (62% or $n = 88$) adolescents had at least one friend who was using alcohol, marijuana, or other illicit substances regularly.

Substance use—Adolescent report of alcohol, tobacco, marijuana, and other illicit drug use was assessed with a paper-and-pencil questionnaire developed for this study as an adaptation and extension of existing measures (e.g., Health Behavior Questionnaire; Jessor, Donovan, & Costa, 1989; National Household Survey of Drug Abuse, 1992). Frequency of heavy alcohol use was the mean of two questions: (a) "In the past 6 months how many times did you get drunk or 'very, very high' on alcohol?" and (b) "In the past 6 months how many times did you drink five or more drinks when you were drinking?". These two items were highly correlated ($r = .85, p < .05$). Frequency of marijuana use was assessed with one question: "How often in the past 6 months did you use marijuana?" Frequency of "other" illicit drug use was the mean of three items that asked how often adolescents used inhalants, cocaine, or hallucinogens. Response options for all of these questions ranged from 1 (*never*) to 9 (*more than twice a week*). Quantity of cigarettes smoked on an average day over the past 6 months was assessed with responses ranging from 1 (*none*) to 7 (*about two packs or more a day*).

Substance use disorder symptoms—Adolescent report of alcohol and marijuana use disorder symptoms (abuse and dependence) were assessed using a highly structured interview version of the Structured Clinical Interview for *DSM-III-R* (Spitzer, Williams, & Gibbon, 1987) that we modeled after Martin and colleagues (Martin, Kaczynski, Maisto, Bukstein, & Moss, 1995; Martin, Pollock, Lynch, & Bukstein, 2000) to include *DSM-IV* substance use disorder criteria and symptoms appropriate for adolescents. The interviews were administered by trained bachelor's level staff in face-to-face interviews and later scored by senior project staff. Each symptom score ranged from 0 (*never experienced the problem*) to 2 (experienced the problem to a clinically significant degree). For this study, summed symptom (problem)

scores for alcohol and marijuana were used as developmentally sensitive indexes of emerging alcohol and marijuana problems in adolescence.

Results

Bivariate Correlations Among Study Variables

Correlations among the predictors, moderators, and outcome variables are presented in Table 1. Substance use and abuse by adolescents across different substance classes are not independent of one another. As shown in Table 1, zero-order correlations among substance use outcome variables in this study ranged from .35 to .75. However, given the nascent state of research on mediators of substance use outcome in children with ADHD and controversy about differential risk for specific substances (Burke et al., 2001; Lambert, 1998), we chose to consider these substance use outcomes independently.

Mediation Analyses

Three conditions are required for mediation. First, there should be a relation between the independent variable and the dependent variable (path *c*) prior to controlling for the variance accounted for by the mediator. Second, there should be a relation between the independent variable and mediator (path *a*), and third, there should be a relation between the mediator and the dependent variable (path *b*; Baron & Kenny, 1986). These paths are depicted in Figure 1. We tested these assumptions using multiple regression analyses to examine whether deviant peer affiliation mediated the relations between childhood ADHD symptoms and each of the six substance use variables. In all models childhood inattention and hyperactivity–impulsivity were entered together to estimate their individual effects above and beyond the effects of the other. Moreover, in all models adolescent age was included as a covariate to control for the variance it shared with deviant peer group affiliation ($r = .39$; $p < .001$) and the substance use outcomes (r s ranging from .14 to .33, with p s ranging from *ns* to $< .001$).

To test path *a*, deviant peer group affiliation was regressed on adolescent age and each of the childhood predictors: inattention symptoms and hyperactivity–impulsivity symptoms. The unstandardized beta for the relation between inattention and deviant peer affiliation was .403, $t(141) = 2.67$, $p = .01$. However, hyperactivity–impulsivity was not significantly associated with deviant peer affiliation, above and beyond childhood inattention and age in this regression analysis, $B = .140$, $t(141) = 1.20$, *ns*, or when tested as a zero-order correlation, $r = .10$, *ns*. As result, we did not test deviant peer affiliation as a mediator of the hyperactivity–impulsivity effect.

Mediation of the inattention effect—Paths *b* and *c* for the inattention effect were estimated by regressing each of the substance use outcomes on childhood inattention symptoms in Step 1 and deviant peer group affiliation in Step 2 (see Table 2). In all of these models, childhood hyperactivity–impulsivity symptoms and age were entered as covariates. Results for path *c* were expected based on past published reports with this sample (cf. Molina & Pelham, 2003) and show that severity of childhood inattention predicted all substance use outcomes. Results for path *b* were also expected (cf. Marshall et al., 2003) and show that deviant peer group affiliation was significantly associated with higher levels of all substance use outcomes (see Table 2).

Each mediated effect was estimated by calculating the product of the unstandardized betas from Step 2 that represent path *a* and path *b* ($a \times b$). Approximate *Z* scores for each mediated effect were estimated by dividing the product by its standard error, $SE(ab)$, where $SE(ab)^2 = SE(a)^2 \times (b)^2 + SE(b)^2 \times (a)^2$ (see MacKinnon & Dwyer, 1993). All of the *Z* scores were above

1.96, suggesting that deviant peer affiliation mediated the relation between childhood inattention and the six substance use outcomes.

Moderated Mediation

Moderated mediation was tested in two steps. First, we tested the hypotheses that childhood ODD or childhood CD or both moderated paths *a* and *b* of the mediator model (see interactions *d* and *e* in Figure 1). Second, we tested the significance of the mediated pathway at different levels of ODD, CD, or both. To complete the first step of these analyses, ODD and CD and their associated interaction terms were entered in as the final step of the original inattention regression models (those that were estimated to test the mediated effects described previously). For example, to test the hypothesis that ODD moderated path *a*, we entered ODD and the interaction term between ODD and inattention symptoms predicting deviant peer affiliation. We estimated a separate model testing the same hypothesis for the interaction between CD and inattention to minimize complications due to multicollinearity between childhood ODD and CD ($r = .47$). The results showed that neither childhood ODD nor CD moderated path *a*. Thus, the relation between childhood inattention symptoms and adolescent deviant peer affiliation did not depend on the level of ODD or CD.¹ We conducted two similar sets of analyses to test whether ODD and CD moderated path *b*.

ODD as a moderator of path *b*—Significant interactions between childhood ODD and deviant peer group affiliation showed that ODD moderated path *b* for four out of the six outcome variables² (see Table 2). All interactions were tested and probed using the methods of Aiken and West (1991), including centering of predictors to reduce nonessential multicollinearity. Simple slopes showing associations between deviant peer affiliation and substance use at low and high levels of ODD are presented in Table 2. The strength of the relation between deviant peer affiliation and substance use was consistently stronger for adolescents with high levels of ODD in childhood than it was for adolescents with low levels of ODD in childhood; however, the association between deviant peer affiliation and two outcome variables (alcohol problems and marijuana use) remained statistically significant at low levels of childhood ODD.

The second step in testing moderated mediation was to test the significance of the mediated pathway at different levels of ODD. To accomplish this we first re-estimated path *a* controlling for childhood ODD (the adjusted $B = .401$, $p < .001$, $SE = .152$). Next, we used the simple slopes derived from the moderator analyses (described previously as path *b* in the mediator model), such that a mediation *Z* score was estimated at high levels of ODD (path ODD_{high}) and at low levels of ODD (path ODD_{low}). These mediation results are presented in Table 3 and support our hypothesis that the mediated pathway through deviant peer affiliation to substance use for these four outcome variables is stronger at high levels of ODD than it is at low levels of ODD (see cigarette use example in Figure 2). As shown in Table 3, the mediated effect for probands with low levels of ODD was nonsignificant for all four outcome variables.

CD as a moderator of path *b*—Results from these analyses showed that childhood CD did not moderate path *b*. One possible explanation for these results is that there was not enough variability in CD symptoms in childhood to serve as a viable moderator. To test this hypothesis

¹Although there was no direct effect of hyperactivity–impulsivity on deviant peer affiliation, conceivably it could still interact with ODD, which would be consistent with the moderated mediation hypothesis; therefore, we tested this model as well; the interaction was not significant.

²None of the childhood CD interactions (paths *d* and *e*) was significant; therefore only the ODD results were presented in Table 2. All ODD models were originally estimated with CD as a covariate, but the results did not change. Therefore, CD was excluded from the final models. Because of the difficulty establishing enough power to detect interaction effects (see Aiken & West, 1991; McClelland & Judd, 1993), a cutoff of $p < .10$ was used to identify potentially meaningful interaction terms.

we examined adolescent CD as a moderator as well. Results from these analyses showed that three out of six interactions between CD and deviant peer affiliation were significant (all p s $< .05$), suggesting that adolescent CD symptoms moderated the relation between deviant peer affiliation and heavy alcohol use, alcohol problems, and marijuana problems. Moderated mediation analyses were examined in the same way that they were for ODD described previously. We reestimated path a controlling for adolescent CD ($B = .270, p < .05, SE = .129$), then we used the simple slopes derived from the moderator analyses described previously as path b in the mediator model, such that a mediation Z score was estimated at high levels of CD (path CD_{high}) and at low levels of CD (path CD_{low}). These results showed that the mediated path at high levels of adolescent CD approached significance for all three variables ($Z = 1.95, p = .05$; $Z = 1.91, p = .06$; and $Z = 1.82, p = .07$, for heavy alcohol use, alcohol problems, and marijuana problems, respectively). The mediated paths at low levels of adolescent CD symptoms were all nonsignificant.

Discussion

This study extends the results of our previous article that examined risk for deviant peer affiliation in children with ADHD and controls (Marshall et al., 2003). We previously reported that childhood ADHD symptom severity predicted adolescent substance use (Molina & Pelham, 2003), that childhood ADHD diagnosis predicted difficulties in peer relationships (Bagwell et al., 2001), and that deviant peer affiliation mediated the relation between childhood ADHD diagnosis and adolescent substance use (Marshall et al., 2003). These findings show that children within the ADHD group are at higher risk for associating with deviant peers if they have higher levels of childhood inattention symptoms. Two important caveats about the inattention effect should be acknowledged here. First, we identified unique shared variance between a continuous measure of child inattention symptoms and later deviant peer affiliation in a sample of children who are also characterized by high levels of impulsivity and hyperactivity. Thus, the cognitive inattention deficits that characterize these children may be qualitatively different from those that characterize children identified primarily as inattentive (Milich, Balentine, & Lynam, 2001). Although we statistically controlled for the confounding effects of hyperactivity–impulsivity symptoms, doing so does not completely control for the possible influences that comorbid hyperactivity–impulsivity symptoms have on the inattention effects (see Pearl, 2000). Second, our measure of childhood ADHD symptoms (which was based on *DSM-III-R* and *DSM-IV* criteria) may not have adequately assessed impulsivity (see Molina & Pelham, 2003). For these reasons the validity and specificity of the inattention effect should be interpreted with caution.

Nevertheless, there is some empirical evidence to suggest that children with severe inattention have difficulties in school (Hynd et al., 1991; Marshall et al., 1997; Molina et al., 2001) and difficulties with their social relationships (Carlson et al., 1987; Maedgen & Carlson, 2000), both of which may lead to deviant peer affiliation (Dishion et al., 1991). Models of adolescent substance use often include such pathways in their conceptual frameworks (see Chassin et al., 2004). Empirical tests of these mediated social failure and school failure pathways to deviancy in children with ADHD would be important next steps to identifying potential modifiable variables that could be targeted in adolescent substance use prevention and intervention programs, as well as contribute to larger models that attempt to delineate the risk and protective factors in children with ADHD.

Our finding that the deviant peer pathway was strongest among youth with ODD or CD provides more evidence to suggest that the long-term outcomes of children with ADHD and comorbid antisocial behaviors are less favorable than they are for children with ADHD only, particularly with regard to later deviant peer and substance use outcomes (cf. Flory & Lynam, 2003; Molina & Pelham, 2003). The role that ODD symptoms play in this close link between

deviant peer culture and substance use makes intuitive sense. For example, in the context of deviant behaviors by their peers, children with low levels of ODD are more likely to heed the warnings and advice of their parents and not succumb to negative peer influences. On the other hand, children with ODD are by definition recalcitrant. When exposed to substance use by their peers, they may be less likely to consider parental guidance and therefore more likely to use substances available among friends. These findings highlight the importance of intervening early in the ADHD child's behavioral trajectory given the apparent vulnerability later for peer-mediated substance use.

Although childhood CD symptoms did not moderate the deviant peer pathway, adolescent CD symptoms did. These results, which are admittedly relying on another concurrent measurement of behavior in adolescence, are consistent with our previous findings that probands with concurrent CD reported higher rates of substance use than did probands without CD (Molina & Pelham, 2003). Thus, these findings indicate that peer influence processes may be part of a connected set of outcomes in adolescence that include conduct violations, heavy substance use and associated negative consequences (e.g., fights with parents over drinking), and deviant peer influences that include not only substance use and substance-tolerant attitudes but fewer mainstream conventional friendships (Bagwell et al., 2001). Interestingly, although the findings suggest that peer influence processes may be important for cigarette smoking, the presence of CD in adolescence is not crucial for this to occur. Other studies have found that risk for cigarette use is independent of CD among youth with ADHD (Burke et al., 2001; Milberger et al., 1997). Moreover, they are consistent with the result of Bagwell et al. (2001) using this sample, which found that probands with CD had more friends who engaged in nonconventional activities and more friends that the parent disapproved of than did probands without CD and controls. In this study, the deleterious effects of deviant peer affiliation were strongest in probands with high levels of inattention and high levels of CD symptoms. These results make intuitive sense as well. In contrast to ODD, the defining feature of CD is defiance toward a broader set of societal norms and rules. Therefore, not only are adolescents with CD more likely to select peers who share their values, they are more likely to engage in deviant behaviors characterizing the group (i.e., substance use and abuse and other nonconventional activities).

Modeling antisocial behavior as a moderator is useful because it allows us to conceptualize and test it as a risk factor; it also allows us to suspend our assumptions about whether it is causally related to ADHD and substance use. This approach is notably different from classic adolescent problem behavior theories, which postulate that antisocial behaviors and substance use are delinquent behaviors that are part of the same problem behavior continuum (Donovan & Jessor, 1985; Jessor & Jessor, 1977). Our results are consistent with critical reviews of the literature (see Flory & Lynam, 2003; Lynam, 1996) and suggest that probands with and without antisocial behaviors may have distinctly different risk trajectories.

There were several other interesting findings in this study. First, it was noteworthy that ODD and CD did not moderate the relation between each of the ADHD symptom domains and deviant peer affiliation (interaction d in Figure 1). That is, ADHD symptom severity in childhood (inattention scores) predicted affiliation with deviant peers equally at all levels of ODD or CD symptoms in childhood. This is inconsistent with some ADHD studies that show that probands with comorbid antisocial behavior have more severe problems in peer functioning than do probands without comorbid aggression (e.g., Hinshaw & Melnick, 1995). However, we previously reported for this sample that persistence of ADHD, and not adolescent CD, was associated with peer rejection in adolescence, suggesting an important contribution of ADHD symptoms to social functioning in adolescence (Bagwell et al., 2001). Pelham and Bender (1982) also reported that the core symptoms of ADHD in childhood, even in the absence of aggression, were associated with poor peer socio-metric ratings. Thus, whereas children

with particularly elevated ADHD symptoms may find themselves out of mainstream social groups (i.e., affiliating with substance-using peers in adolescence), vulnerability to socially mediated substance use may be most relevant (or only relevant) for defiant youth. These findings are interesting in light of recent concerns about “deviancy training” that may occur among youth at risk for delinquent behavior (Poulin, Dishion, & Burraston, 2001). To the extent that our probands with ODD are similarly at risk, our findings suggest that such bidirectional social influence processes (e.g., Curran, 2000) may occur naturally but for only a subgroup of probands. Finally, it is important to recognize that deviant peer affiliation and adolescent substance use were both measured in adolescence in this study and were both assessed using the same reporter. These limitations preclude our ability to make confident statements about temporal precedence and the strength of each of the unidirectional effects separate from shared method variance. There is a well-documented bidirectional relation between deviant peer affiliation and adolescent substance use (e.g., Curran, 2000), and several studies suggest that both selection and influence processes can explain the strong relation between the two (Ennett & Baumann, 1994). Thus, although we have conceptualized and tested models that support influence processes, we believe selection processes are occurring as well.

In sum, this study identified several modifiable risk factors for developing substance use and abuse in adolescence by providing evidence that deviant peer affiliation mediates the relation between childhood inattention symptoms and adolescent substance use or abuse and by showing that these mediated effects were moderated by childhood ODD and adolescent CD. These results suggest that risk for adolescent substance use may be reduced in several ways. First, risk may be reduced by employing effective interventions that decrease ongoing childhood ADHD, ODD, and adolescent CD symptoms; however, long-lasting intervention effects on the core symptoms of ADHD have yet to be demonstrated (see Smith, Waschbusch, Willoughby, & Evans 2000). Second, increasing parent monitoring and the quality of the parent–child relationship may help buffer the effects of deviant peer affiliation on later substance use (Marshall & Chassin, 2000). Third, increasing children's coping skills might reduce the effects of ADHD on later substance use such as nicotine (Molina, Marshall, Pelham, & Wirth, 2005). Finally, it is important to recognize that risk for substance use in this population may be driven largely by the negative academic and social sequelae that develop in children with ADHD and that prevention and intervention programs that focus on remediation of impairment (i.e., peer rejection, school failure) in childhood may ultimately prove to be the most successful in curbing long-term deleterious outcomes.

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References

- Aiken, L.S.; West, S.G. Multiple regression: Testing and interpreting interactions. Sage; Newbury Park, CA: 1991.
- American Psychiatric Association. Diagnostic and statistical manual of mental disorders. Vol. 3rd ed.. Author; Washington, DC: 1987. rev.
- American Psychiatric Association. Diagnostic and statistical manual of mental disorders. Vol. 4th ed.. Author; Washington, DC: 1994.

- Atkins MS, Pelham WE, Licht M. A comparison of objective classroom measures and teacher ratings of attention deficit disorder. *Journal of Abnormal Child Psychology* 1985;13:155–167. [PubMed: 3973249]
- Bagwell C, Molina BSG, Pelham WE, Hoza B. Attention-deficit hyperactivity disorder and problems in peer relations: Predictions from childhood to adolescence. *Journal of the American Academy of Child & Adolescent Psychiatry* 2001;40:1285–1292. [PubMed: 11699802]
- Barkley RA, Fischer M, Edelbrock CS, Smallish L. The adolescent outcome of hyperactive children diagnosed by research criteria: I. An 8-year prospective follow-up study. *Journal of the American Academy of Child & Adolescent Psychiatry* 1990;29:546–557. [PubMed: 2387789]
- Baron RM, Kenny DA. The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology* 1986;51:1173–1182. [PubMed: 3806354]
- Burke JD, Loeber R, Lahey BB. Which aspects of ADHD are associated with tobacco use in early adolescence? *Journal of Child Psychology & Psychiatry* 2001;42:493–502. [PubMed: 11383965]
- Burns GL, Walsh JA. The influence of ADHD–hyperactivity/impulsivity symptoms on the development of oppositional defiant disorder symptoms in a 2-year longitudinal study. *Journal of Abnormal Child Psychology* 2002;30:245–256. [PubMed: 12041710]
- Carlson CL, Lahey BB, Frame CL, Walker J, Hynd GW. Sociometric status of clinic-referred children with attention deficit disorders with and without hyperactivity. *Journal of Abnormal Child Psychology* 1987;15:537–547. [PubMed: 3437089]
- Chassin L, Pillow DR, Curran PJ, Molina BSG, Barrera M Jr. Relation of parental alcoholism to early adolescent substance use: A test of three mediating mechanisms. *Journal of Abnormal Psychology* 1993;102:3–19. [PubMed: 8436697]
- Chassin, L.; Hussong, A.; Barrera, M., Jr.; Molina, BSG.; Trim, R.; Ritter, J. Adolescent substance use.. In: Lerner, RM.; Steinberg, L., editors. *Handbook of adolescent psychology*. Vol. 2nd ed.. Wiley; Hoboken, NJ: 2004. p. 199-230.
- Cohen, J. *Statistical power analyses for the behavioral sciences*. Vol. 2nd ed.. Lawrence Erlbaum Associates, Inc.; Hillsdale, NJ: 1988.
- Coie JD, Terry R, Lenox K, Lochman J. Childhood peer rejection and aggression as predictors of stable patterns of adolescent disorder. *Development & Psychopathology* 1995;7:697–713.
- Coie, JD.; Terry, R.; Zakriski, A.; Lochman, J. Early adolescent social influences on delinquent behavior.. In: McCord, J., editor. *Coercion and punishment in long-term perspectives*. Cambridge University Press; New York: 1995. p. 229-244.
- Curran, P. A latent curve framework for the study of developmental trajectories in adolescent substance use.. In: Rose, JS.; Chassin, L.; Presson, CC.; Sherman, SJ., editors. *Multivariate applications in substance use research*. Lawrence Erlbaum Associates, Inc.; Mahwah, NJ: 2000. p. 1-42.
- Dishion TJ, Patterson GR, Stoolmiller M, Skinner ML. Family, school, and behavioral antecedents to early adolescent involvement with antisocial peers. *Developmental Psychology* 1991;27:172–180.
- Donaldson, SI. Mediator and moderator analysis in program development.. In: Sussman, S., editor. *Handbook of program development for health and behavior research & practice*. Sage; Thousand Oaks, CA: 2001. p. 470-496.
- Donovan JE, Jessor R. Structure of problem behavior in adolescence and early adulthood. *Journal of Consulting and Clinical Psychology* 1985;53:890–904. [PubMed: 4086689]
- Ennett ST, Bauman KE. The contribution of influence and selection to adolescent peer group homogeneity: The case of adolescent cigarette smoking. *Journal of Personality and Social Psychology* 1994;67:653–663. [PubMed: 7965611]
- Flory K, Lynam D. The relation between attention deficit hyperactivity disorder and substance abuse: What role does conduct disorder play? *Clinical Child and Family Psychology Review* 2003;6:1–16. [PubMed: 12659448]
- Gittelman R, Mannuzza S, Shenker R, Bonagura N. Hyperactive boys almost grown up: I. Psychiatric status. *Archives of General Psychiatry* 1985;42:937–947. [PubMed: 4037987]
- Goyette CH, Conners CK, Ulrich RF. Normative data on revised Conners' Parent and Teacher Rating Scales. *Journal of Abnormal Child Psychology* 1978;6:221–236. [PubMed: 670589]

- Hartsough CS, Lambert NM. Pattern and progression of drug use among hyperactives and controls: A prospective short-term longitudinal study. *Journal of Child Psychology & Psychiatry* 1987;28:543–553. [PubMed: 3654806]
- Hawkins JD, Catalano RF, Miller JY. Risk and protective factors for alcohol and other drug problems in adolescence and early adulthood: Implications for substance abuse prevention. *Psychological Bulletin* 1992;112:64–105. [PubMed: 1529040]
- Henker, B.; Whalen, CK. The child with attention-deficit/hyperactivity disorder in school and peer settings.. In: Quay, HC.; Hogan, AE., editors. *Handbook of disruptive behavior disorders*. Plenum; New York: 1999. p. 157-178.
- Hinshaw SP, Melnick SM. Peer relationships in boys with attention-deficit hyperactivity disorder with and without comorbid aggression. *Development & Psychopathology* 1995;7:627–647.
- Hynd GW, Lorys AR, Semrud-Clikeman M, Nieves N, Huettner MIS, Lahey BB. Attention deficit disorder without hyperactivity: A distinct behavioral and neuro-cognitive syndrome. *Journal of Child Neurology* 1991;6:S37–S43. [PubMed: 2002215]
- James LR, Brett JM. Mediators, moderators, and tests for mediation. *Journal of Applied Psychology* 1984;69:307–321.
- Jessor, R.; Donovan, JE.; Costa, FM. *Health Behavior Questionnaire*. University of Colorado, Institute of Behavioral Science; Boulder: 1989.
- Jessor, R.; Jessor, SL. *Problem behavior and psychosocial development: A longitudinal study of youth*. Academic; New York: 1977.
- Johnston, L.; O'Malley, P.; Bachman, J. *Illicit drug use, smoking and drinking by America's high school students, college students, and young adults, 1975–1987*. U.S. Government Printing Office; Washington, DC: 1988.
- Johnston C, Pelham WE, Murphy HA. Peer relationships in ADHD and normal children: A developmental analysis of peer and teacher ratings. *Journal of Abnormal Child Psychology* 1985;13:89–100. [PubMed: 3973254]
- Lambert, NL. Stimulant treatment as a risk factor for nicotine use and substance abuse.. Paper presented at the National Institute of Mental Health Consensus Conference on Attention Deficit Hyperactivity Disorder; Bethesda, MD. Nov. 1998
- Loeber R, Keenan K. Interaction between conduct disorder and its comorbid conditions: Effects of age and gender. *Clinical Psychology Review* 1994;14:497–523.
- Loney, J.; Milich, R. Hyperactivity, inattention, and aggression in clinical practice.. In: Wolraich, M.; Routh, DK., editors. *Advances in developmental and behavioral pediatrics*. Vol. 3. JAI; Greenwich, CT: 1982. p. 113-147.
- Lynam DR. Early identification of chronic offenders: Who is the fledging psychopath? *Psychological Bulletin* 1996;120:209–234. [PubMed: 8831297]
- MacKinnon DP, Dwyer JH. Estimating mediated effects in prevention studies. *Evaluation Review* 1993;17:144–158.
- Maedgen JW, Carlson CL. Social functioning and emotion regulation in the attention deficit hyperactivity disorder subtypes. *Journal of Clinical Child Psychology* 2000;29:30–42. [PubMed: 10693030]
- Mannuzza, S.; Klein, RG. Adolescent and adult outcomes in attention-deficit/hyperactivity disorder.. In: Quay, HC.; Hogan, AE., editors. *Handbook of disruptive behavior disorders*. Kluwer Academic/Plenum; New York: 1999. p. 279-294.
- Marshal MP, Chassin L. Peer influence on adolescent alcohol use: The moderating role of parental support and discipline. *Applied Developmental Science* 2000;4:80–88.
- Marshal MP, Molina B, Pelham WE. Deviant peer affiliation as a risk factor for substance use in adolescents with childhood ADHD. *Psychology of Addictive Behaviors* 2003;17:293–302. [PubMed: 14640825]
- Marshall RM, Hynd GW, Handwerk MJ, Hall J. Academic underachievement in ADHD subtypes. *Journal of Learning Disabilities* 1997;30:635–642. [PubMed: 9364901]
- Martin CS, Kaczynski NA, Maisto SA, Bukstein OG, Moss HB. Patterns of *DSM-IV* alcohol abuse and dependence symptoms in adolescent drinkers. *Journal of Studies on Alcohol* 1995;56:672–680. [PubMed: 8558899]

- Martin CS, Pollock NK, Lynch KG, Bukstein OG. Inter-rater reliability of the SCID substance use disorder section in adolescents. *Drug and Alcohol Dependence* 2000;59:173–176. [PubMed: 10891630]
- McClelland GH, Judd CM. Statistical difficulties of detecting interactions and moderator effects. *Psychological Bulletin* 1993;114:376–390. [PubMed: 8416037]
- Milberger S, Biederman J, Faraone SV, Chen L, Jones J. ADHD is associated with early initiation of cigarette smoking in children and adolescents. *Journal of Academic Child Adolescent Psychiatry* 1997;36:37–44.
- Milich R, Balentine AC, Lynam DR. ADHD combined type and ADHD predominantly inattentive type are distinct and unrelated disorders. *Clinical Psychology: Science and Practice* 2001;8:463–488.
- Moffitt TE. Adolescence-limited and life-course-persistent antisocial behavior: A developmental taxonomy. *Psychological Review* 1993;100:674–701. [PubMed: 8255953]
- Molina BSG, Pelham WE. Childhood predictors of adolescent substance use in a longitudinal study of children with ADHD. *Journal of Abnormal Psychology* 2003;112:497–507. [PubMed: 12943028]
- Molina BSG, Marshal MP, Pelham WE, Wirth RJ. Deficient coping skills and daily smoking among adolescents with and without childhood ADHD. *Journal of Pediatric Psychology* 2005;30:345–357. [PubMed: 15863431]
- Molina B, Smith B, Pelham WE. Factor structure and criterion validity of secondary school teacher ratings of ADHD and ODD. *Journal of Abnormal Child Psychology* 2001;29:71–82. [PubMed: 11316336]
- Morgan-Lopez AA, Castro FG, Chassin L, MacKinnon DP. A mediated moderation model of cigarette use among Mexican American youth. *Addictive Behaviors* 2003;28:583–589. [PubMed: 12628629]
- National Household Survey on Drug Abuse. U.S. Department of Health and Human Services, Public Health Service. Alcohol, Drug Abuse and Mental Health Administration. National Institute on Drug Abuse; Washington, DC: 1992. OMB No. 0930–0110
- Pearl, J. *Causality: Models, reasoning, and inference*. Cambridge University Press; Cambridge, England: 2000.
- Pelham, WE.; Bender, ME. Peer relationships in hyper-active children: Description and treatment.. In: Gadow, KD.; Bialer, L., editors. *Advances in learning and behavioral disabilities*. Vol. I. JAI; Greenwich, CT: 1982. p. 365-436.
- Pelham WE, Gnagy E, Greenslade KE, Milich R. Teacher ratings of *DSM-III-R* symptoms for the disruptive behavior disorders. *Journal of the American Academy of Child & Adolescent Psychiatry* 1992;31:210–218. [PubMed: 1564021]
- Pelham WE, Hoza B, Pillow DR, Gnagy EM, Kipp HL, Greiner AR, et al. Effects of methylphenidate and expectancy on children with ADHD: Behavior, academic performance, and attributions in a summer treatment program and regular classroom settings. *Journal of Consulting and Clinical Psychology* 2002;70:320–335. [PubMed: 11952190]
- Petraitis J, Flay BR, Miller TQ. Reviewing theories of adolescent substance use: Organizing pieces of the puzzle. *Psychological Bulletin* 1995;117:67–86. [PubMed: 7870864]
- Poulin F, Dishion TJ, Burraston B. Three-year iatrogenic effects associated with aggregating high-risk adolescents in cognitive-behavioral preventive interventions. *Applied Developmental Science* 2001;5:214–224.
- Shaffer D, Fisher P, Dulcan MK, Davies M, Piacentini J, Schwab-Stone ME, et al. The NIMH Diagnostic Interview Schedule for Children Version 2.3 (DISC-2.3): Description, acceptability, prevalence rates, and performance in the MECA study. *Journal of the American Academy of Child & Adolescent Psychiatry* 1996;5:865–877. [PubMed: 8768346]
- Shaffer D, Fisher P, Lucas CP, Dulcan MK, Schwab-Stone ME. NIMH Diagnostic Interview Schedule for Children Version IV (NIMH DISC-IV): Description, differences from previous versions, and reliability of some common diagnoses. *Journal of the American Academy of Child & Adolescent Psychiatry* 2000;39:28–38. [PubMed: 10638065]
- Smith BH, Waschbusch D, Willoughby M, Evans S. The efficacy, safety, and practicality of treatments for adolescents with attention-deficit/hyperactivity disorder. *Clinical Child and Family Psychology Review* 2000;3:243–267. [PubMed: 11225739]
- Spitzer, R.; Williams, J.; Gibbon, B. *Instruction manual for the Structured Clinical Interview for DSM-III-R*. New York State Psychiatric Institute; New York: 1987.

- Tein JY, Sandler IN, MacKinnon DP, Wolchik SA. How did it work? Who did it work for? Mediation in the context of a moderated prevention effect for children of divorce. *Journal of Consulting & Clinical Psychology* 2004;72:617–624. [PubMed: 15301646]
- Whalen CK, Henker B. The social worlds of hyperactive (ADHD) children. *Clinical Psychology Review* 1985;5:447–478.
- Wheeler J, Carlson CL. The social functioning of children with ADD with hyperactivity and ADD without hyperactivity: A comparison of their peer relations and social deficits. *Journal of Emotional and Behavioral Disorders* 1994;2:2–12.

Figure 1.
An illustration of a moderated mediation model predicting adolescent substance use in children with ADHD.

Figure 2. Childhood ODD as a moderator of the mediated pathway from childhood inattention symptoms to adolescent cigarette use.

Table 1

Bivariate Correlations Among Study Variables

	1	2	3	4	5	6	7	8	9	10	11	12
1. Childhood Inattention	1.0	.27**	.20*	.22**	.09	.27**	.32***	.25*	.27**	.23**	.24**	.15
2. Childhood Hyperactivity–Impulsivity	—	1.0	.43***	.21**	-.14	.10	.08	.13	.11	.01	.10	.08
3. Childhood ODD	—	—	1.0	.29**	.07	.13	.07	.19*	.17*	.21**	.18*	.22**
4. Adolescent CD	—	—	—	1.0	.21*	.48***	.43***	.45***	.39***	.43***	.45***	.36***
5. Adolescent Age	—	—	—	—	1.0	.38***	.33***	.30***	.32***	.27**	.19*	.14
6. Adolescent Deviant Peer Affiliation	—	—	—	—	—	1.0	.56***	.53***	.52***	.45***	.43***	.29***
7. Adolescent Heavy Alcohol Use	—	—	—	—	—	—	1.0	.74***	.72***	.65***	.43***	.53***
8. Adolescent Alcohol Symptoms	—	—	—	—	—	—	—	1.0	.59***	.72***	.46***	.65***
9. Adolescent Marijuana Use	—	—	—	—	—	—	—	—	1.0	.73***	.47***	.53***
10. Adolescent Marijuana Symptoms	—	—	—	—	—	—	—	—	—	1.0	.47***	.75***
11. Adolescent Cigarette Use	—	—	—	—	—	—	—	—	—	—	1.0	.35***
12. Adolescent Other Drug Use	—	—	—	—	—	—	—	—	—	—	—	1.0

Note: ODD = oppositional defiant disorder; CD = conduct disorder.

Table 2

Regression of Adolescent Substance Use on Adolescent Age, Childhood ADHD Symptoms, Deviant Peer Group Affiliation, ODD, and the Interaction Between ODD and Deviant Peer Group Affiliation

Step 1	Heavy Alcohol Use	Alcohol Problems	Marijuana Use	Marijuana Problems	Quantity of Cigarettes	Illicit Drug Use ^a
Adolescent Age	.31***	.30***	.31***	.25**	.19*	0.59**
Childhood Hyp-Imp Symptoms	.05	.12	.10	-.02	.06	0.82
Childhood Inattention Symptoms (Path c)	.28***	.19*	.21**	.20*	.20*	2.70***
Total R ²	.19***	.16***	.17***	.11**	.09**	0.24
Step 2						
Adolescent Age	.14	.14	.16*	.11	.05	0.17
Childhood Hyp-Imp Symptoms	.00	.08	.05	-.05	.03	0.70
Childhood Inattention Symptoms (Path c')	.17*	.09	.13	.12	.1	1.38
Deviant Peer Affiliation (Path b)	.46***	.46***	.42***	.38***	.39***	1.78**
Change in R ²	.17***	.16***	.14***	.12***	.12***	0.17
Total R ²	.36***	.32***	.31***	.23***	.21***	0.41
Step 3						
Adolescent Age	.14	.13	.15	.09	.04	0.15
Childhood Hyp-Imp Symptoms	.03	.05	.03	-.12	.00	0.59
Childhood Inattention Symptoms	.19*	.10	.14	.13	.12	1.60
Deviant Peer Affiliation	.45***	.42***	.39***	.33***	.35***	1.60**
ODD	-.04	.11	.09	.22**	.12	0.67
ODD × Deviant Peer Affiliation (Path e)	.06	.13 [†]	.13 [†]	.18*	.16*	1.20
Effects of Deviant Peer Affiliation at:						
Low levels of ODD		.29*	.26*	.15	.18	
High levels of ODD		.56***	.52***	.52***	.51***	
Change in R ²	.00	.02	.02	.06**	.03 [†]	0.07
Total R ²	.36***	.34***	.33***	.28***	.24***	0.48

Note: ADHD = attention deficit hyperactivity disorder; ODD = Oppositional Defiant Disorder; Hyp-Imp = hyperactive-impulsive. Values in the table are standardized regression coefficients. Significance tests for Nagelkerke R^2 estimates were unavailable; However, chi-square values that estimate goodness of fit via improvement in baseline -2 log likelihood estimates at each step were all significant at $p < .001$.

^a Illicit drug use was highly skewed, therefore it was dichotomized and analyzed using logistic regression. Values in this column are unstandardized beta coefficients from the logistic regression model and Nagelkerke pseudo R^2 estimates.

* $p < .10$.
 * $p < .05$.
 ** $p < .01$.
 *** $p < .001$.

Table 3
Unstandardized Beta Coefficients Used to Estimate Mediated Effects at High and Low Levels of Childhood ODD

	Path A		Path B		Mediated Effect (A × B)	Z Score	p value
	β	SE	β	SE			
Alcohol Problems							
ODD _{low}	.401	.152	1.502	.655	0.602	1.73	ns
ODD _{high}	.401	.152	2.935	.523	1.177	2.39	< .05
Marijuana Use							
ODD _{low}	.401	.152	0.844	.405	0.338	1.64	ns
ODD _{high}	.401	.152	1.695	.324	0.680	2.36	< .05
Marijuana Problems							
ODD _{low}	.401	.152	0.960	.827	0.385	1.06	ns
ODD _{high}	.401	.152	3.306	.661	1.326	2.33	< .05
Cigarette Use							
ODD _{low}	.401	.152	0.222	.172	0.089	1.16	ns
ODD _{high}	.401	.152	0.645	.139	0.259	2.29	< .05

Note: ODD = Oppositional Defiant Disorder.