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Childhood ADHD and Adolescent Substance Use: An Examination of Deviant Peer Group Affiliation as a Risk Factor

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Abstract

Deviant peer group affiliation was evaluated as a risk factor for substance use in adolescents with childhood attention-deficit/hyperactivity disorder (ADHD). Results showed that deviant peer affiliation mediated the relationship between ADHD and substance use, suggesting that children with ADHD are more likely than children without ADHD to become involved with deviant peers and, as a result, more likely to use substances. Moreover, the relationship between deviant peer affiliation and substance use was stronger for adolescents with ADHD, suggesting that once they are immersed in a deviant peer group, adolescents with ADHD are more vulnerable to the negative social influences of that group. This study is the first step in identifying high-risk pathways from childhood ADHD to substance use in adolescence.

Attention-deficit/hyperactivity disorder (ADHD) is a persistent and pervasive mental health problem that first appears in childhood and comprises two primary symptom domains: (a) inattention and (b) impulsivity–hyperactivity (American Psychiatric Association, 1994). Several decades of research have shown that clinically significant levels of ADHD symptoms interfere with academic and social functioning (Barkley, 1998). Indeed, children with ADHD—especially boys, who are six to nine times more likely than girls to have ADHD in clinic-referred settings—experience impairment in many areas of functioning that may cause significant adjustment problems later in life. For example, a recent review concluded that childhood ADHD continues to be a risk factor for academic, behavioral, and social functioning difficulties in adolescence and young adulthood (see Mannuzza & Klein, 1999).

Within the domain of possible adverse behavioral outcomes for children with ADHD is early use of drugs and alcohol. Although there is controversy surrounding the magnitude and cause of the effect, children who are clinic referred for ADHD appear to be at risk for early substance use. For example, adolescents with childhood hyperactivity more often reported cigarette, alcohol, and marijuana use than did control participants (Barkley, Fischer, Edelbrock, & Smallish, 1990), although the alcohol and marijuana group differences were

discounted because of Bonferroni correction. Milberger and colleagues (Milberger, Biederman, Faraone, Chen, & Jones, 1997) reported significantly more cigarette smoking among adolescents with childhood ADHD than among control participants but not significantly more psychoactive substance use disorders (Biederman et al., 1997). The latter finding is most likely attributable to the young average age of the participants (about 15 years). For example, Gittelman, Mannuzza, Shenker, and Bonagura (1985) reported more drug use disorders in their late adolescent males with childhood hyperactivity than in boys without childhood hyperactivity. With some exceptions for tobacco (Burke, Loeber, & Lahey, 2001; Milberger et al., 1997), substance use by adolescents with childhood ADHD is strongly associated with the development of conduct problems in these same individuals (Barkley et al., 1990; Gittelman et al., 1985). This result is not surprising given the robust, although imperfect, association between the two behavioral domains of substance use and conduct problems (Mason & Windle, 2002). The important, potentially mediating role of conduct problems is also consistent with theoretical models of early-onset alcoholism common among males (Sher, 1991; Zucker, Ellis, & Fitzgerald, 1993; Zucker & Gomberg, 1986).

To date, there are very few studies that test models attempting to explain ADHD risk for substance use and substance use problems in adolescence. We think that a reasonable starting point lies in examination of the peer environment. Affiliation with peers who also engage in, or tolerate, substance use and other deviant behaviors should be an influential risk factor, because it has been linked empirically and theoretically with both ADHD and adolescent substance use and abuse. Several decades of research, mostly with boys, show that children with ADHD have psychosocial functioning deficits that place them at higher risk for failure in conventional social circles, which could cause them to gravitate toward nonconventional peer groups. To the extent that affiliation with substance-using peers is a well-established proximal risk factor for substance use, one useful first step in attempting to explain ADHD risk for early substance use may be to examine the role of peers in relation to substance use and in relation to the theoretically important conduct problem domain.

ADHD and Social Functioning

A hallmark characteristic of children with ADHD is their difficulty with establishing and maintaining healthy peer relationships. Indeed, one of the reasons ADHD is considered a “disruptive behavior” disorder is because the core features of ADHD (inattention and impulsivity–hyperactivity) inevitably interfere with normal social developmental tasks. For example, children with ADHD display social information-processing deficits, impulsive sensation-seeking behaviors, and difficulties regulating their behavior and emotion during social interactions with other children (Pelham & Bender, 1982; Whalen & Henker, 1992). These social impairments in childhood are likely to decrease positive interactions with non-ADHD peers and increase the likelihood of affiliation with a deviant peer group in childhood and in adolescence. This shift in peer group affiliation can be a result of voluntary and involuntary processes. For example, in a series of studies, Henker and Whalen (1999) found that boys with ADHD were more likely than their nondiagnosed peers to rate “trouble” making peers as “fun to be with.” Moreover, Hinshaw and Melnick (1995) found that boys with ADHD were more likely to befriend children with ADHD than their non-ADHD peers. On the other hand, children who are rejected by peers may gravitate to deviant peer groups by default. The continuation of this pattern into adolescence is suggested by our own findings that children with ADHD are more likely than non-ADHD age-mates to have friends of whom their parents disapprove (Bagwell, Molina, Pelham, & Hoza, 2001). Moreover, social deficits persist into adolescence in the form of parent- and teacher-reported peer rejection.

Deviant Peer Group Affiliation and Substance Use Problems

Deviant peer group affiliation is a central component of most, if not all, adolescent substance use theories (see Petraitis, Flay, & Miller, 1995) and is considered the strongest and most consistent correlate of adolescent substance use (Hawkins, Catalano, & Miller, 1992). For children with ADHD, deviant peer affiliation may operate as a risk factor for substance use in two ways. First, because children with ADHD are more likely to affiliate with deviant peers than children without ADHD, and because deviant peer affiliation is one of the strongest risk factors for adolescent substance use, children with ADHD may be at higher risk for substance use. That is, we hypothesized that deviant peer affiliation mediates the relationship between childhood ADHD and adolescent substance use behaviors. This hypothesis follows directly from the deviance-proneness pathway found in Sher's (1991) model of alcoholism vulnerability, in which difficult temperament leads to pathological alcohol involvement by way of peer influence. The first goal of this study was to test this mediator model.

Second, once adolescents are involved with a deviant peer group, those with a history of ADHD might be at higher risk for substance use because they are more vulnerable to the influences of the deviant peer culture. Although selection of like-minded peers (e.g., substance using and substance-tolerant peers) by adolescents with ADHD is probably occurring to some extent (Ennett & Bauman, 1994), immersion in the subculture may foster continued or escalated substance use for several reasons. Poor social skills in males with ADHD may render them less capable of maintaining peer group acceptance using conventional social strategies. As a result, they may be more likely to use maladaptive strategies such as alcohol and drug use to maintain acceptance by and status within their peer group. Impulsive decision making and other intrapersonal characteristics that likely follow from the cognitive deficits common to children with ADHD (e.g., inadequate coping skills, inability to delay gratification) may also escalate vulnerability in the context of peer deviance. Thus, we also hypothesized that ADHD would moderate the association between peer deviance and substance use such that immersion in a deviant peer group would be more tightly associated with substance use and other conduct problems for children with ADHD than for children without ADHD. The second goal of this study was to test this moderator model.

Molina and Pelham (2003) recently conducted a study to evaluate the magnitude of risk for adolescent substance use in clinic-referred children with ADHD and to evaluate the role of childhood ADHD symptoms, ADHD persistence, and comorbid conduct disorder symptoms in explaining this risk. The goals of the present study were to build on Molina and Pelham's study by considering the role of concurrent affiliation with deviant peers, operationalized as perceived substance use by peers and perceived tolerance of substance use by peers, in the development of substance use. Because of the correlation between conduct disorder symptoms and substance use in our sample and in other similar samples (e.g., Gittelman et al., 1985), and its theoretical mediational role in the development of adolescent substance use, we also examined it as an outcome of affiliation with deviant peers. We hypothesized that both mediating (i.e., deviant peer affiliation as a mediator of the association between ADHD and substance use) and moderating processes (i.e., deviant peer affiliation is more strongly associated with substance use in the ADHD than in the non-ADHD group) were likely to occur, placing children with ADHD at higher risk for both conduct problems and substance use in adolescence. To date, we do not know of any studies that evaluated the role of deviant peer affiliation in the development of substance use behaviors in adolescents with childhood ADHD.

Method

Participants

Participants in the current study were 142 adolescents with childhood ADHD (probands) and 100 demographically similar adolescents without childhood ADHD (controls). The mean age for the total sample was 15.2 years ($SD = 1.4$), and ages ranged from 13 to 18 years. Eighty seven percent of the adolescents were Caucasian, 10% 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 of graduating high school. On average, adolescents had completed 9.5 ($SD = 1.5$) years of school. The majority of adolescents lived in a two-parent household (71%). All of the mothers, and 96% of the fathers, had graduated from high school or received their high school equivalency degree. Forty-three percent of the mothers, and 46% of the fathers, had graduated from college. Total family income ranged from \$1,400 to \$300,000 per year, and the median family income was \$48,000. There were no statistically significant differences between the ADHD and non-ADHD groups on adolescent age, gender, ethnicity, parent level of education, and proportion of single-parent households.

Adolescents with childhood ADHD—All probands received a diagnosis of ADHD in childhood according to *Diagnostic and Statistical Manual of Mental Disorders* (3rd ed., rev.; *DSM-III-R*; American Psychiatric Association, 1987) or *DSM-IV* (4th ed.; American Psychiatric Association, 1994) criteria. Probands were recruited as adolescents from the attention deficit disorder clinic records at Western Psychiatric Institute and Clinic, University of Pittsburgh Medical Center, for services received between the years of 1987 and 1995, when they were children. In childhood, parents and teachers completed a packet of intake measures that included the Disruptive Behavior Disorders Scale (DBD; 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 PhD 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.

Participating probands were between the ages of 5 and 17 at the time of their childhood assessment, although most (88.7% of 142) were between 5 and 12 years old. An average of 5.26 years elapsed between the childhood assessment and the follow-up interview in adolescence ($SD = 2.22$ years, range = 0–11 years).¹ At follow-up, eligible children and their parents were contacted to participate in a second interview. Of the contacted eligible children, 56.5% participated in the follow-up study. There were no statistically significant

¹Sixteen participants were adolescents at the time of the initial assessment (during participation in the Summer Treatment Program; Pelham & Hoza, 1996), and 3 of them provided their follow-up data soon afterward (i.e., follow-up interval = 0 years). To control for the potential effects of earlier substance use in this older subgroup, and to control for the lack of prospective association between the assessment of ADHD diagnosis and substance use behaviors in 3 of these participants, all analyses were rerun with them excluded. Because the results did not change, these cases were retained.

differences between participants and nonparticipants in childhood variables measuring ADHD, oppositional defiant disorder, and conduct disorder symptoms (in either parent or teacher report of *DSM* symptoms) or in full-scale IQ or achievement test scores (reading and math).

Adolescents without childhood ADHD—One hundred demographically similar adolescents without childhood ADHD (controls) were recruited during adolescence from the greater Pittsburgh area by means of newspaper advertisements (54%); flyers in schools attended by the probands (9%); advertisements in the university hospital voicemail system or newsletter, which reaches a large network of hospital staff (26%); or other (e.g., word of mouth; 11%). The control participants were not interviewed in childhood; rather, they were recruited in adolescence using a phone screening procedure with the parents and subsequently interviewed in the ADHD program offices. The screening questionnaire was used over the phone with interested parents to ascertain demographic characteristics, history of diagnosis or treatment for ADHD, presence of exclusionary criteria listed above (e.g., low IQ), and to administer a checklist of ADHD symptoms from the DBD (Pelham et al., 1992). Participants were eligible for inclusion in the comparison sample if they did not have a history or current diagnosis of ADHD based on parent and teacher reports on the DBD and by the Diagnostic Interview Schedule for Children (DISC) version 2.3 (Shaffer et al., 1996) completed by their mothers. Control participants were selected to ensure similarity between the proband and non-ADHD groups on age, gender, race, parental education, and single-versus two-parent households.

Procedure

In adolescence, all teenagers (probands and controls) participated with their parents in a one-time, office-based interview. After informed consent was obtained, 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; see details below). Confidentiality of information was supported with a Certificate of Confidentiality from the U.S. Department of Health and Human Services with certain exceptions (e.g., suicidality, child abuse), and the protocol was approved by the University of Pittsburgh institutional review board. At least three teachers of primary academic subjects were asked to complete ratings of behavior and academic performance. Additional details regarding participant recruitment and procedures are in Molina and Pelham (2003) and Bagwell et al. (2001).

Measures

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, National Institute on 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 2 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* (SCID; Spitzer, Williams, & Gibbon, 1987) that we modeled after work by 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; for example, “Have you ever had a drop in grades due to your drinking?” SCIDs 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 indices of emerging alcohol and marijuana problems in adolescence.

Substance use and abuse across different substance classes are not independent of one another; however, for the most part these behaviors are more distinct than similar. For example, in this study, zero-order correlations among substance use outcome variables (.34–.75) suggest that they share anywhere from 12% to 56% of variance. Moreover, 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, recognizing the possibility of conceptual overlap among them.

Conduct disorder symptoms—In adolescence, we measured conduct disorder symptoms using the parent and adolescent reports of current symptoms on the DISC (version 2.3 or 3.0; Shaffer et al., 1996). In this study, we used a continuous measure of the sum of 15 *DSM-IV* conduct disorder symptoms in the past 6 months as endorsed by either the adolescent or parent.

Deviant peer affiliation—Deviant peer affiliation 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 (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 whether their close friends would *strongly disapprove* (1) to *strongly approve* (5) of him or her engaging in these same six forms of substance use as well as “weekend heavy alcohol use.” The correlation between the mean of the peer use items and the mean of the peer tolerance of use items was fairly strong ($r = .64, p < .0001$), 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 significantly correlated with two single-item, dichotomous measures (yes–no) of mother’s disapproval of the adolescent’s friends ($r = .26, p < .001$) and mother’s disapproval of the adolescent’s friends’ behavior ($r = .24, p < .001$), suggesting modest overlap between perceived peer substance use/tolerance of use and the broader construct of peer deviance. In this sample, most (60%, $n = 142$) adolescents had at least one friend who used alcohol, marijuana, or other illicit substances regularly, suggesting that a substantial portion of the participants’ friends were meaningfully involved with drugs and alcohol.

Results

The mean scores and effect sizes for the ADHD group comparisons on the six substance use variables of interest in the current study are listed in Table 1. These comparisons are also reported by Molina and Pelham (2003) but are presented here again as a point of departure for tests of the mediation and moderation hypotheses.² Compared with standards proposed by Cohen (1988), statistically significant effect sizes range from small (.31) to moderate (.42). In addition, childhood ADHD predicted adolescent conduct disorder symptoms, and the effect was moderate in size (.52). Table 1 also lists the mean scores and effect sizes for adolescents' report of their peers' substance use, tolerance of use, and total peer use/tolerance scores. The ADHD group effect sizes for the peer variables were statistically significant but small in size.

Mediation Analyses

A mediated effect is considered a “generative mechanism” through which an independent variable influences the dependent variable (Baron & Kenny, 1986). Three assumptions are made when one is testing mediation: (a) there is a relationship between the independent variable and the dependent variable (path *c*) prior to controlling for the variance accounted for by the mediator, and there is (a) a relationship between the independent variable and mediator (path *a*), and (b) between the mediator and the dependent variable (path *b*; Baron & Kenny, 1986). These paths are illustrated for this study in Figure 1. We tested these assumptions using multiple regression analyses for each of the five substance use variables that were significantly different between groups and for adolescent conduct disorder symptoms. Although in previous articles (e.g., Molina & Pelham, 2003) conduct disorder symptoms have been conceptualized as a partial mediator of the association between childhood ADHD and adolescent substance use, in the current study we treated it as an outcome correlated with substance use to simplify the analytic strategy. In all models, adolescent age was included as a covariate to control for the variance it shared with deviant peer group affiliation and the substance use outcomes. To test path *a*, we regressed deviant peer group affiliation onto adolescent age and ADHD status. In this study, path *a* is the same for every model, $\beta = .222$, $t(241) = 2.42$, $p = .02$, and is consistent with the hypothesis that adolescents with childhood ADHD would report higher levels of perceived peer substance use and perceived peer tolerance of use than adolescents without childhood ADHD.

We estimated paths *b* and *c* by regressing each of the substance use outcomes on adolescent age and childhood ADHD status in Step 1 and deviant peer group affiliation in Step 2 (see Table 2). After controlling for adolescent age, the results for path *c* are consistent with the *t* tests reported in Table 1 and suggest that adolescents with childhood ADHD reported higher levels of cigarette use, heavy alcohol use, alcohol symptoms, illicit drug use, and conduct disorder symptoms than adolescents without childhood ADHD. Results for Path B suggest that deviant peer group affiliation was significantly associated with higher levels of all substance use outcomes.

We estimated each mediated effect by calculating the product of the unstandardized betas from Step 2 that represent path *a* and path *b* ($a \times b$). We estimated approximate *z* scores for each mediated effect by dividing the product by its standard error ($SE[ab]$), where: $SE(ab)^2 = SE(a)^2 \times (b)^2 + SE(b)^2 \times (a)^2$ (MacKinnon & Dwyer, 1993). All of the *z* scores were above 1.96, suggesting that deviant peer affiliation mediated the relationship between childhood ADHD status and all of the adolescent substance use and conduct disorder outcomes. To determine whether deviant peer affiliation partially or fully mediated the

²Molina and Pelham (2003) used a single heavy alcohol use item assessing the number of times drunk in the past 6 months.

effects of ADHD on the various outcome measures, we re-evaluated the magnitude of the beta for path c' after deviant peer affiliation was added to the models. To the extent that statistical significance of the ADHD effect was eliminated, the results suggested that deviant peer affiliation fully mediated the effects of ADHD status on adolescent heavy alcohol use, alcohol symptoms, and marijuana use. Deviant peer group only partially mediated the relationship between ADHD and cigarette use, illicit drug use, and conduct disorder symptoms, such that the effects of ADHD remained significant after controlling for deviant peer group affiliation.

Moderation Analyses

The hypothesized interaction was that the relationship between deviant peer affiliation and adolescent substance use is stronger for adolescents with childhood ADHD than for adolescents without childhood ADHD. To test this hypothesis, we entered the interaction between ADHD status and deviant peer affiliation on the third step of each of the six regression models that we estimated for the mediation analyses (see Table 2). We also regressed marijuana symptoms onto this interaction, but because the interaction was not statistically significant, we excluded it from Table 2. All interactions were tested and probed using the methods of Aiken and West (1991), including centering of predictors in order to reduce nonessential multicollinearity. Variance inflation factors in the third step across all models ranged acceptably from 1.017 to 1.173.

In the final regression model, R^2 values indicated that 10%–32% of the variance in the outcomes was explained by the complete set of variables. The distributions of the outcome variables were skewed (skew values ranged from 2.21 to 7.02) because of low base rates of some substance use and conduct disorder behaviors in adolescence, which may have violated the regression assumption that variables are normally distributed. To ensure that this did not influence the results, we reran all mediation and moderation analyses using robust estimation in Mplus (Muthen & Muthen, 1998). Using this procedure did not change the interpretation of the results; therefore, regression estimations were reported.

Four statistically significant interactions were found. The pattern of results was very similar for three of the interactions, where deviant peer affiliation was more strongly associated with adolescent substance use for probands than for controls. This result occurred for heavy alcohol use: $B = 0.55$, $t(241) = 7.75$, $p = .0001$, for probands, $B = 0.28$, $t(241) = 3.06$, $p = .01$, for controls; for alcohol problems: $B = 0.54$, $t(241) = 7.53$, $p = .0001$, for probands, $B = 0.29$, $t(241) = 3.15$, $p = .01$, for controls; and for conduct disorder symptoms: $B = 0.54$, $t(241) = 7.39$, $p = .0001$, for probands, $B = 0.28$, $t(241) = 2.97$, $p = .01$, for controls. For purposes of illustration, simple slopes for the regression of heavy alcohol use onto deviant peer affiliation in each subgroup are plotted in Figure 2. A slightly different pattern emerged for illicit drug use. There was a moderately strong relationship between deviant peer affiliation and illicit drug use for the probands, $B = 0.34$, $t(241) = 4.21$, $p = .0001$, and no relationship between the two for the controls, $B = 0.02$, $t(241) = 0.168$, ns (see Figure 3).

Discussion

This study evaluated the role of deviant peer group affiliation, operationalized as perceived peer substance use and perceived peer tolerance of substance use, in the relationship between childhood ADHD and adolescent substance abuse. Three findings are important. First, adolescents with childhood ADHD were more likely than controls to report affiliation with deviant peers. Second, this affiliation either partially or fully mediated the effects of childhood ADHD on adolescent substance use and conduct problems. Third, the connection between deviant peer affiliation and self-reported substance use was stronger for probands

than for controls, suggesting a tighter connection between exposure to peer modeling of this behavior and substance use in probands than in controls.

The results of this study are consistent with previous findings in children (Hinshaw & Melnick, 1995; C. Johnston, Pelham, & Murphy, 1985; Pelham & Bender, 1982; Whalen & Henker, 1985) that ADHD is associated with significant problems in peer relationships. Indeed, it has long been known that children with ADHD are often socially rejected, receiving fewer positive and more negative nominations than comparison groups in classroom sociometric studies (C. Johnston et al., 1985). Combined with our earlier findings in this sample of peer rejection among the probands in adolescence (Bagwell et al., 2001), the current results suggest that the negative effects of peer rejection might spill over into deviant peer cultures that include peer substance use and substance use tolerance. This finding is important given the strong role played by peer substance use in the developmental course of adolescent substance use behaviors (Hawkins et al., 1992; Petraitis et al., 1995). Moreover, that deviant peer group affiliation mediated the association between childhood ADHD and later substance use is a natural extension of Molina and Pelham's (2003) study, which found a fairly robust association between childhood ADHD and adolescent substance use. Investigation to further identify the links in the mediational chain to peer-mediated substance use in children with ADHD is needed.

Some substance-specific results emerged. The most prominent pattern that emerged was that quantity of cigarette use was only partially mediated by perceived peer substance use and that the association between perceived substance use and quantity of cigarette use was similar between probands and controls. These findings are intriguing because of the potentially unique mechanisms underlying addiction to nicotine versus other substances in children with ADHD. In contrast to other drugs of abuse, cigarette smoking is not fully mediated by the development of conduct disorder in children with ADHD (Burke et al., 2001; Milberger et al., 1997; Molina & Pelham, 2003), which suggests a need to consider alternative pathways to nicotine addiction among children with ADHD. These pathways might include self-medication to improve attentional functioning (e.g., Khanzian, 1997; Milberger et al., 1997) or behavioral sensitization to nicotine resulting from previous treatment with psychostimulants (Robinson & Berridge, 2000). The findings in the current study suggest that cigarette smoking among children with ADHD is not entirely socially mediated either, which indirectly bolsters the argument for considering these alternative pathways. It is possible that our exclusion of peer smoking behavior from the peer substance use measure partly accounts for these findings; we will test this possibility in subsequent waves of our longitudinal research.

Etiological theories of substance use disorders suggest that problems with substance use likely evolve in the context of both proximal and distal risk factors experienced across the life span (Petraitis et al., 1995; Windle & Davies, 1999). In this framework, early emerging high-risk temperament/personality characteristics such as ADHD symptoms may serve as distal risk factors, whereas deviant peer affiliation serves as a proximal risk factor. Developmental trajectories of problem alcohol or substance use might include high-risk mediating pathways from distal risk factors to more proximal risk factors through psychosocial/interpersonal phenomena. For example, as inattention symptoms emerge in early childhood, they may interfere with social developmental learning processes (for a review, see Henker & Whalen, 1999). Failure to learn and use normative social behaviors may result in rejection by conventional peers. This rejection can lead to gravitation toward a deviant, nonconventional peer group, which may foster substance use behavior (i.e., a "peer rejection" pathway). Impulsive-hyperactive symptoms may also lead to nonconventional or deviant peer group affiliation but perhaps in part through different mediating mechanisms; that is, rather than gravitating toward these peers because of rejection, children with

impulsivity–hyperactivity might seek out nonconventional or deviant peers because interacting with them and engaging in deviant behavior is perceived as stimulating (i.e., a sensation-seeking pathway). Each of these mediational pathways may explain the putative theoretical link between high risk temperament/personality characteristics in childhood and the development of substance use disorders in adolescence and young adulthood (Sher, 1991; Windle & Davies, 1999). For use of other substances that may be explained by alternative pathways to addiction (e.g., nicotine), deviant peer affiliation may primarily serve a different role, for example, as an exposure mechanism. Future research should focus on identifying empirical support for these different mediated pathways in order to provide a foundation for prevention and intervention program mediators that can be targeted in order to reduce risk of adolescent substance abuse problems.

Some of the very same interpersonal characteristics in children with ADHD that lead to affiliation with deviant peers may also be responsible for heightening their susceptibility to peer influence (the moderation finding), thus explaining the occurrence of simultaneously occurring mediating and moderating processes of substance use risk. For example, children with a history of peer rejection might be more likely to engage in deviant behaviors as a means of gaining peer acceptance by the deviant peer culture. Moreover, impulsive tendencies in the presence of deviant peers may result in drug use without consideration for the negative consequences of use, thereby increasing susceptibility in the face of temptation. An alternative interpretation, and one that we could address in this study, is that children with ADHD perceive higher levels of substance use by their peers than actually occur, especially when they are users themselves. Adolescents who use substances often inflate their estimates of substance use by their peers (for a review, see Bauman & Ennett, 1996), and it is unknown whether children with ADHD are more susceptible than children without ADHD to these errors. In addition, an important caveat in our results is that we could not, in this study, address the expected bidirectional influences between affiliation with deviant peers and substance use.

As suggested by comprehensive models of the development of substance use disorders (Petraitis et al., 1995; Sher, 1991; Windle & Davies, 1999), many other risk and protective factors play a role in risk and resilience. Given that deviant peer affiliation is a strong proximal risk factor, future research should focus on the interpersonal and intrapersonal factors that might buffer or exacerbate its deleterious effects. For example, we recently found in this sample that rates of social anxiety were higher among our probands than among our controls (Bagwell et al., 2001). Whether and how this social anxiety, combined with social skill deficits, translates into peer-mediated substance use would be of interest. In addition, parenting behaviors such as support, monitoring, and discipline, and other environmental factors, such as family structure (e.g., two-parent vs. one-parent families) might curb the effects of peer substance use behavior on adolescent substance use behavior. A growing literature supports this hypothesis (Brook, Brook, Gordon, Whiteman, & Cohen, 1990; Farrell & White, 1998; Marshal & Chassin, 2000; Mason, Cauce, Gonzales, & Hiraga, 1994). Given that the effects of deviant peer affiliation on adolescent substance use behavior are stronger for children with ADHD, children with ADHD and their families might benefit from parenting strategies that specifically focus on this vulnerability.

Some caution is warranted when generalizing these results to the population of ADHD children as a whole, because our sample of ADHD children was mostly Caucasian and consisted of almost all boys. Little is known about the differences between boys and girls in the manifestation of ADHD symptomatology and its negative psychosocial and cognitive sequelae. However, one recent study found that an ethnically diverse sample of girls with ADHD displayed more internalizing and externalizing behaviors, poorer cognitive and academic functioning, and higher peer disapproval rates than did their nondiagnosed female

peers (Hinshaw, 2002), suggesting that they might also be at risk for deviant peer affiliation and substance use in adolescence. It will be interesting to see if the results from the current study are replicated with such samples. Some caution is also warranted when evaluating the role of deviant peer affiliation in substance use behaviors versus other deviant behaviors. The association between deviant peer group affiliation and both drug use behaviors and conduct problems is consistent with social psychological theories of drug abuse that include drug abuse as part of a general tendency toward deviance (Jessor & Jessor, 1977). However, the modest effect size found between conduct problems and substance use in our sample and in other studies (Mason & Windle, 2002), and the differential pattern of effects across our various outcome measures, causes us to continue to maintain these outcomes as distinct entities warranting simultaneous investigation.

Investigation of adolescent substance use, including theory attempting to integrate the results from studies of drug use risk factors, is demanding research that recognizes the interplay of both distal (e.g., temperament and personality) and proximal (e.g., peer environment) influences on substance use (e.g., Petraitis et al., 1995). At the same time, causes of the variability in the long-term adjustment, including substance use and abuse, of children with ADHD is poorly understood. Within high-risk populations, such as children of alcoholics, dispositional vulnerabilities such as poor behavioral control and cognitive deficits are widely recognized distal risk factors for alcoholism and drug abuse (Sher, 1991). Children with ADHD are diagnosed on the basis of these deficits; however, their heterogeneous outcomes beyond childhood warrant further investigation of models that might explain variability in substance use outcomes. Indeed, children with ADHD have the same behavioral dysregulation and cognitive deficits as these other high-risk populations (Pelham & Lang, 1993). By testing a model that examined the mediating role of the peer environment, as well as the potential interactive effects of childhood ADHD and peer deviancy on adolescent substance use, the current study took an initial step forward toward explaining ADHD vulnerability for precocious involvement with drugs and alcohol.

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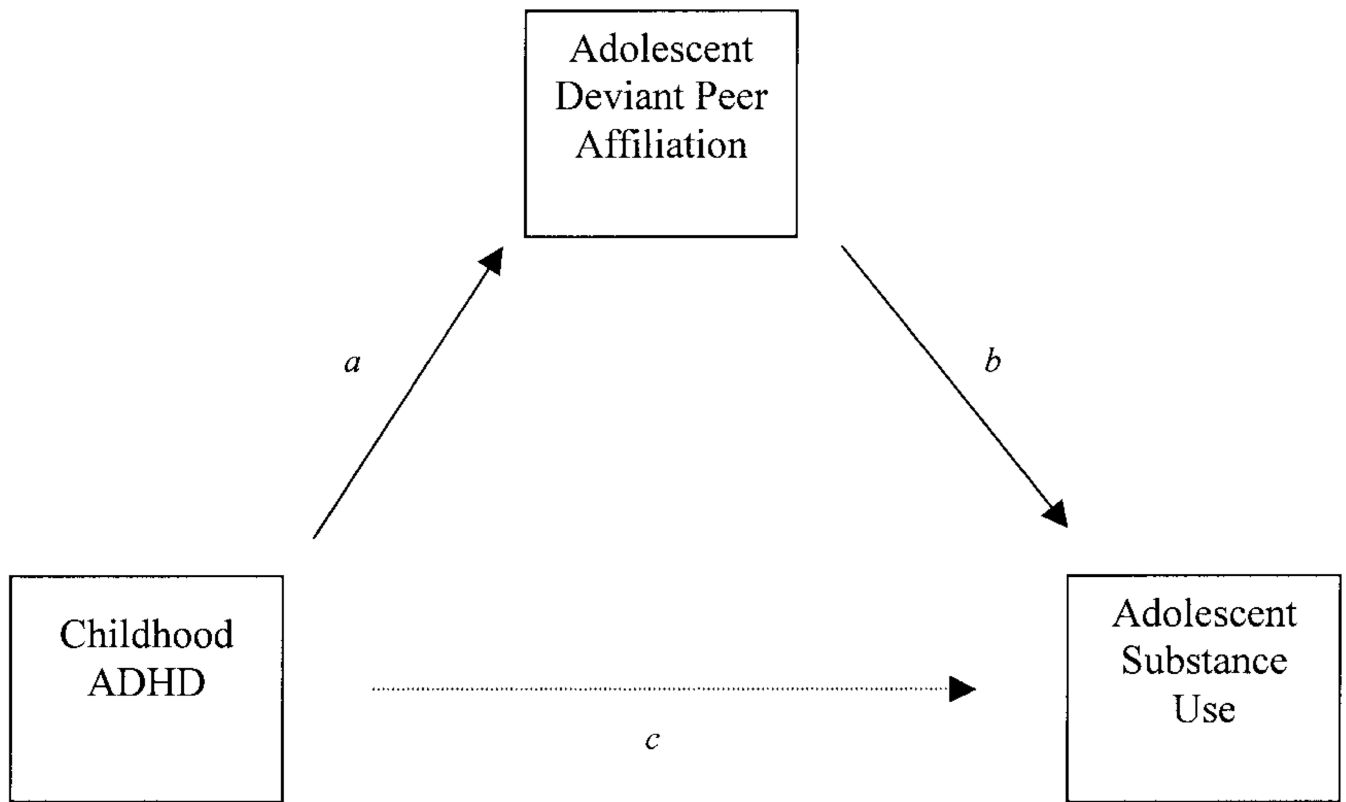


Figure 1. An illustration of the mediating effects of adolescent deviant peer affiliation in the relationship between childhood attention-deficit/hyperactivity disorder (ADHD) and adolescent substance abuse.

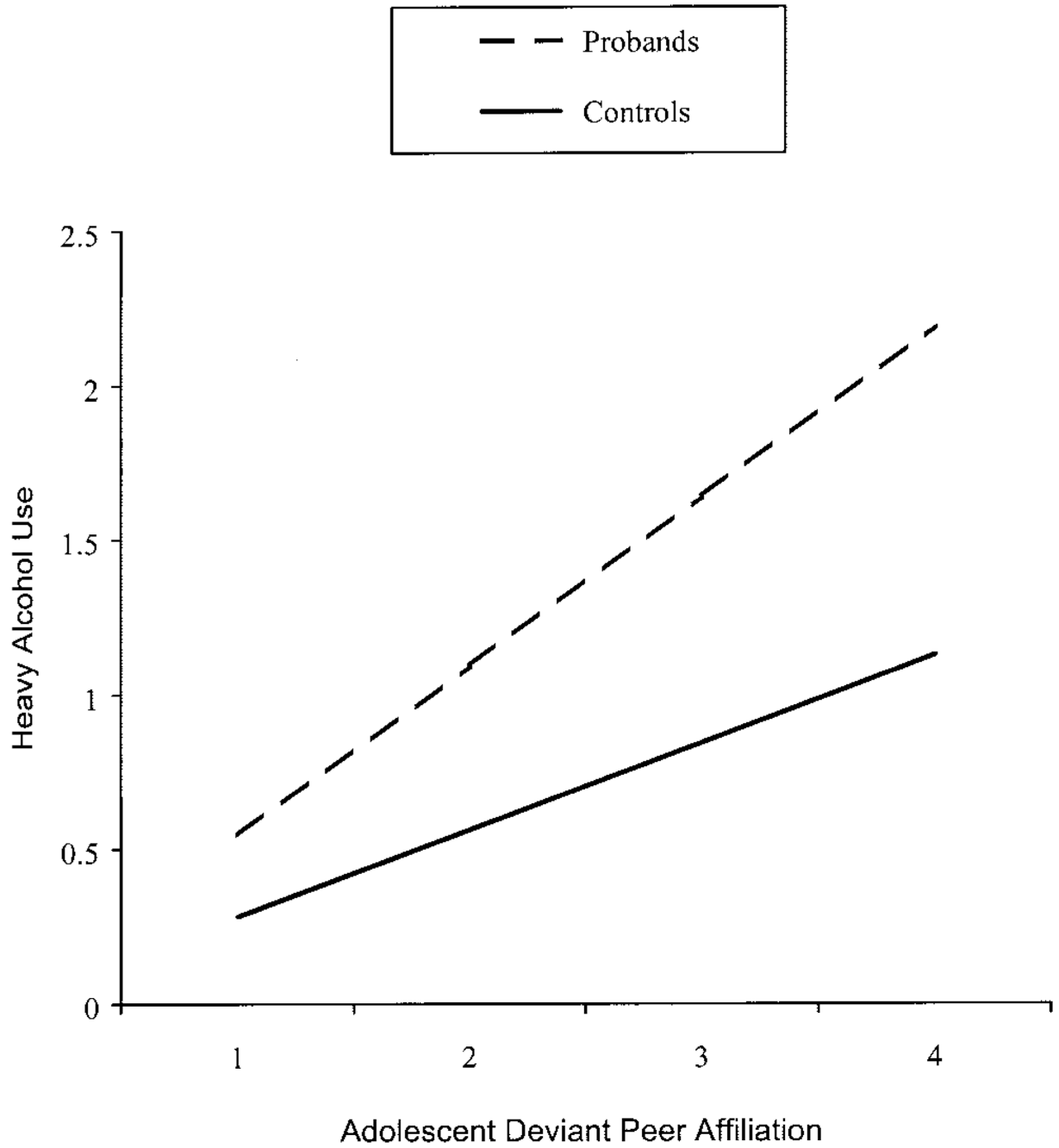


Figure 2. Regression of heavy alcohol use onto adolescent deviant peer affiliation for probands and controls.

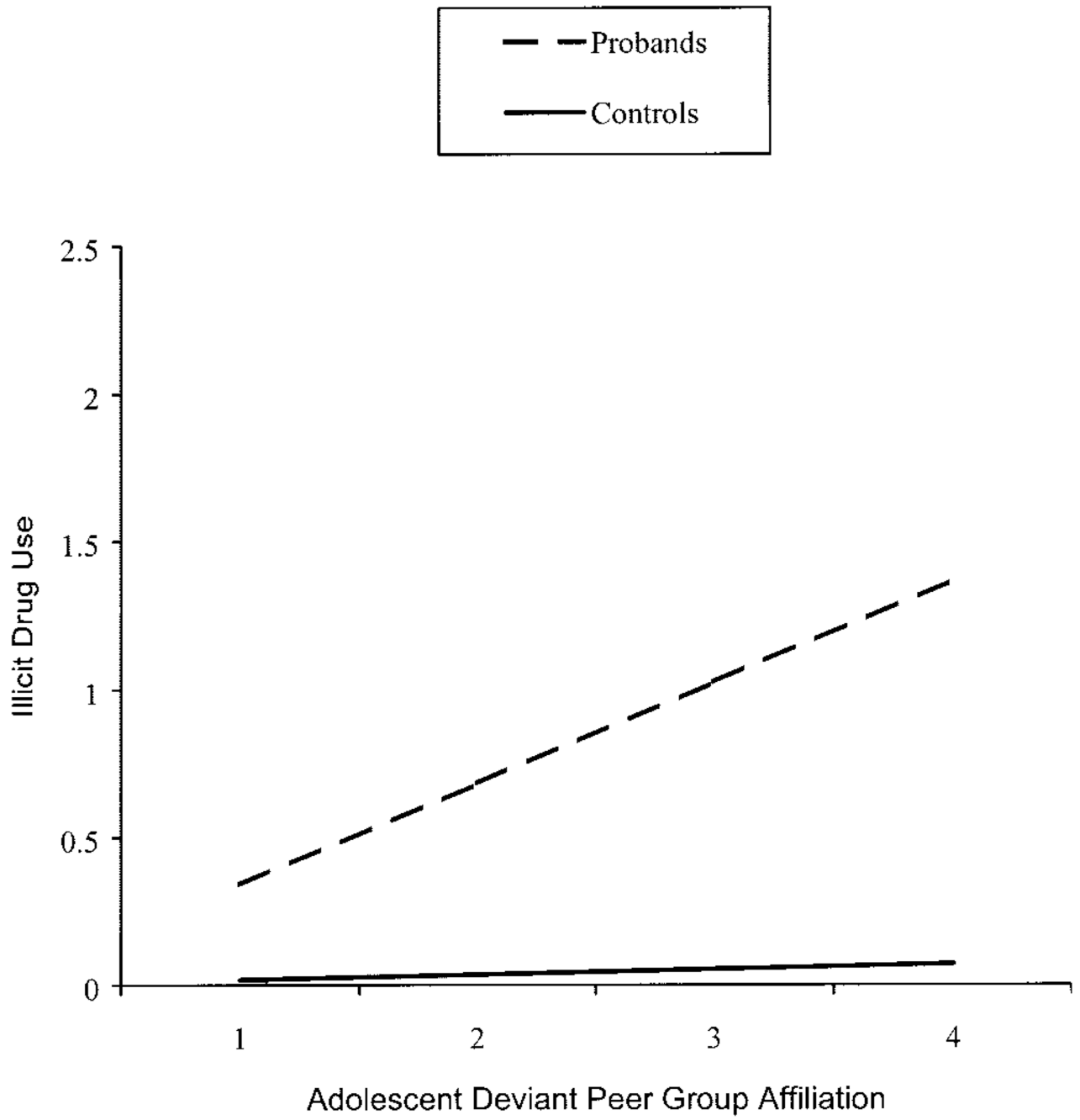


Figure 3. Regression of illicit drug use onto adolescent deviant peer affiliation for probands and controls.

Table 1

Differences Between Adolescents With and Without Childhood Attention-Deficit/Hyperactivity Disorder Regarding Mean Levels of Own Substance Use, Perceived Peer Substance Use, and Perceived Peer Tolerance of Use

Measure	Controls (n = 100)		Probands (n = 142)		Cohen's <i>d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
Adolescent substance use					
Quantity of cigarettes ^a	1.20	0.65	1.55	0.98	.42***
Heavy alcohol use ^b	1.43	1.06	1.87	1.65	.32*
Alcohol problems	1.08	2.51	2.15	4.12	.31*
Frequency of marijuana use ^b	1.58	1.51	2.30	2.52	.35***
Marijuana problems	1.13	2.94	1.89	4.99	.18
Any illicit drug use ^b	1.01	0.07	1.11	0.39	.34*
Conduct disorder symptoms	0.80	0.97	1.60	1.95	.52***
Adolescent deviant peer affiliation					
Perceived peer substance use	1.78	0.84	2.00	0.90	.25*
Perceived peer tolerance of use	1.99	0.72	2.22	0.82	.29*
Total mean	1.89	0.70	2.11	0.78	.30*

^a 0 = none, 1 = less than 1 cigarette/day, 2 = 1–5 cigarettes/day, 3 = ~1/2 packs/day, 4 = ~1 pack/day in past 6 months.

^b Items on each of these subscales were answered on the following response scale: 1 = not at all, 2 = once, 3 = 2–3 times, 4 = 4–5 times, 5 = once a month, 6 = 2 or 3 days a month, 7 = once a week, 8 = twice a week, 9 = more than twice a week in past 6 months.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 2

Regression of Adolescent Substance Use and Conduct Disorder Symptoms on Adolescent Age, Childhood Attention-Deficit/Hyperactivity Disorder (ADHD) Status, Deviant Peer Group Affiliation, and the Interaction Between ADHD Status and Deviant Peer Group Affiliation

Step and variable	Quantity of cigarettes	Heavy alcohol use	Alcohol problems	Frequency of marijuana use	Any illicit drug use	Conduct disorder symptoms
Step 1						
Adolescent age	.20***	.33***	.31***	.31***	.11	.15**
Childhood ADHD status (Path c)	.20***	.15**	.15*	.16**	.16*	.24***
Step 2						
Adolescent age	.06	.18**	.15**	.16**	.03	.00
Childhood ADHD status (Path c')	.13*	.09	.08	.10	.12*	.17**
Deviant peer affiliation (Path b)	.40***	.45***	.45***	.45***	.22**	.45***
Step 3						
Adolescent age	.06	.17***	.15**	.15**	.03	.00
Childhood ADHD status	.13*	.10	.09	.10	.13*	.18**
Deviant peer affiliation	.40***	.55***	.44***	.44***	.21**	.44***
ADHD × deviant peer affiliation	.06	.13*	.12*	.10	.16**	.12*
Total R ²	.22***	.32***	.30***	.31***	.10***	.27***

* $p < .05$.

** $p < .01$.

*** $p < .001$.