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Adolescent Girls' ADHD Symptoms and Young Adult Driving: The Role of Perceived Deviant Peer Affiliation

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Abstract

Objective—Our goal was to examine the role of adolescent perceived deviant peer affiliation in mediating or moderating the association between adolescent attention-deficit/hyperactivity disorder (ADHD) symptoms and young adult driving risk in females with and without ADHD.

Method—The overall sample included 228 ethnically and socioeconomically diverse girls with or without a diagnosis of ADHD in childhood (Wave 1; 6–12 years) followed through adolescence (Wave 2; 11–18 years) and into young adulthood (Wave 3; 17–24 years). A subsample of 103 girls with a driving license by Wave 3 and with full data for all study variables was utilized in this investigation. In adolescence, mothers and teachers reported on ADHD symptoms (inattention and hyperactivity/impulsivity), and participants reported on perceived deviant peer affiliation. In young adulthood, participants reported on driving behavior and outcomes, including number of accidents, number of moving vehicle citations, and ever having driven illegally. Covariates included age and adolescent conduct disorder/oppositional defiant disorder.

Results—Inattention directly predicted citations. Perceived deviant peer affiliation mediated the association between inattention and (a) accidents and (b) citations. Additionally, perceived deviant peer affiliation moderated the association between hyperactivity/impulsivity and accidents, with hyperactivity/impulsivity predicting accidents only for those with low perceived deviant peer affiliation.

Conclusions—Perceived deviant peer affiliation appears to play an important role in the association between ADHD symptoms and driving outcomes. Our findings provide preliminary evidence that both ADHD symptoms and peer processes should be targeted in interventions that aim to prevent negative driving outcomes in young women with and without ADHD.

Keywords

ADHD; deviant peer; driving; risky behavior

Attention-deficit/hyperactivity disorder (ADHD) is a prevalent developmental disorder characterized by deficits in attention, impulse control, and emotional/behavioral regulation. It comprises three subtypes: those who are predominantly inattentive (ADHD-I), those who are predominantly hyperactive/impulsive (ADHD-HI), and those who exhibit a combined profile of inattention and hyperactivity/impulsivity (ADHD-C) (American Psychiatric Association, 2000). Approximately 7–8% of children meet criteria for ADHD; 80% of childhood cases of ADHD persist into adolescence, and about 50–66% of childhood cases

persist into adulthood (Barkley, 2006). ADHD in adulthood is associated with functional impairments in educational, occupational, and relational domains (Weiss & Murray, 2003). Moreover, ADHD is associated with risky behaviors in adolescence and young adulthood, including affiliation with deviant peers (Marsal, Molina, & Pelham, 2003), sexual risk taking (Flory, Molina, Pelham, Gnagy, & Smith, 2006), substance use (Molina & Pelham, 2003), and risky driving (Barkley & Cox, 2007; Jerome, Segal, & Habinski, 2006). Regarding the latter, the National Center for Health Statistics' most recent mortality data reveal that motor vehicle accidents are the leading cause of death for 15–20 year-olds (National Highway Traffic Safety Administration, 2012). Despite a recently decreasing trend of young driver fatalities (National Highway Traffic Safety Administration, 2012), risky driving remains a major public health problem. Our focus herein is on driving-related risk in young adult females, with specific focus on the predictive value of adolescent ADHD symptoms and perceived deviant peer affiliation.

The association between ADHD and driving behavior has been widely examined in cross-sectional and longitudinal investigations with community and clinical samples. In brief, cross-sectional studies have consistently found associations between ADHD and negative driving outcomes, including traffic citations, particularly for speeding (Barkley, Murphy, & Kwasnik, 1996; Barkley, Murphy, Dupaul, & Bush, 2002), crashes (Barkley et al., 1996; Barkley et al., 2002), license suspensions/revocations (Barkley et al., 1996; Barkley et al., 2002), and likelihood of highway accidents, being rear-ended, and crashes causing injury (Barkley et al., 1996; Fried et al., 2006), as well as lack of general driving knowledge in the context of rapid decision-making (Barkley et al., 2002). Many such findings have been validated via self-report, official driving records, and objective measures (Barkley et al., 1996; Barkley et al., 2002; Biederman et al., 2007; Reimer, Mehler, D'Ambrosio, & Fried, 2010). For instance, young adults with ADHD have more erratic steering, vehicle scrapes, and crashes (Barkley et al., 1996) during driving simulations than do controls. In addition, young adult drivers with ADHD rate themselves as using poorer driving habits than controls, as do other raters (Barkley et al., 1996; Barkley et al., 2002). Adults with ADHD likewise self-report various instances of impaired driving, including driving errors, attentional lapses, and violations on the road; comorbidities and neuropsychological impairment may predict worse driving outcomes (Fried et al., 2006). Even so, Barkley and colleagues (2002) found evidence that the association between ADHD and driving difficulties is not merely a function of comorbidity with oppositional defiant disorder (ODD), depression, anxiety, or alcohol/drug use. In one study that examined ADHD symptom dimensions, self-reported adolescent inattention (but not hyperactivity/impulsivity) uniquely predicted self-reported errors and violations along with state records of crashes and citations (Garner et al., 2012).

Results of longitudinal studies have been largely consistent with cross-sectional findings. One of the earliest such investigations found that adolescents with ADHD (especially those with comorbid ODD/conduct disorder [CD] symptoms) were at increased risk of parent-reported negative driving outcomes three to five years later, including driving without a license, license suspensions or revocations, traffic citations, multiple vehicle crashes, and less sound driving habits (Barkley, Guevremont, Anastopoulos, DuPaul, & Shelton, 1993). Likewise, a nationally-sponsored survey that utilized driving records found that severe childhood ADHD was associated with greater likelihood of citations and number of fatal crashes, and marginally predicted frequency of crashes (Lambert, 1995, cited in Barkley and Cox, 2007). A more recent, multi-method, multi-informant study identified that hyperactivity in childhood predicted increased risk of traffic citations, citations for reckless driving, driving without a license, hit-and-run accidents, license suspensions/revocations, higher costs of damage in initial crashes, unsafe driving behavior, and decreased performance on a simulated driving test (Fischer, Barkley, Smallish, & Fletcher, 2007). This

work mirrors a longitudinal investigation in which the association between ADHD and negative driving outcomes was mediated by hyperactivity/impulsivity (Thompson, Molina, Pelham, & Gnagy, 2007). In addition, attentional difficulties are associated with increased risk of accidents involving injuries, driving without a license, and other traffic violations even after adjusting for covariates such as gender, conduct problems, length of time licensed, and distance driven (Woodward, Fergusson, & Horwood, 2000). Thus, both inattention and hyperactivity/impulsivity may be predictive of negative driving outcomes, but additional data are needed. Although few studies have closely investigated the effect of participant sex in this line of research, one epidemiological study did find that ADHD symptomatology in females predicted greater likelihood of driving offenses and crashes compared to females with CD, anxious/depressive disorder, or no disorder (Nada-Raja et al., 1997).

A number of investigations have highlighted potential explanations for the association between ADHD and negative driving outcomes. For example, several characteristics common in ADHD, including inattention/distraction, emotional dysregulation, and irritability, are associated with driving risks in non-clinical samples (Chliaoutakis et al., 2002; Donovan, Queisser, Salzberg, & Umlauf, 1985; Lam, 2002). Furthermore, executive functioning deficits may be associated with driving risks even with control of ADHD severity (Barkley et al., 2002). Evidence also suggests that adults with ADHD are quite susceptible to the impairing effects of alcohol on attention and rating scales of simulator driving (Barkley, Murphy, O'Connell, & Connor, 2006), and that adults with ADHD resemble intoxicated drivers in terms of their driving impairment (Weafer, Camarillo, Fillmore, Milich, & Marcinski, 2008). College students with high ADHD symptoms are especially likely to self-report angry or aggressive driving (Richards, Deffenbacher, & Rosén, 2002), and young adults with high ADHD symptoms report more frustration and exhibit more tactical driving impairment than those with low symptoms (Oliver, Nigg, Cassavaugh, & Backs, 2011). In all, poor regulation of negative emotions may be at least partially responsible for negative driving outcomes in those with ADHD, but further longitudinal research is needed to better understand underlying mechanisms.

In a separate line of research, deviant peer affiliation has been tied to risky behaviors in both longitudinal and cross-sectional investigations. For example, self- and/or other-reported association with deviant peers is associated with several domains of risky behavior in girls and boys, including substance use (Dishion, Capaldi, Spracklen, & Li, 1995; Kirisci, Mezzich, Reynolds, Tarter, & Aytaclar, 2009; Lynne, 2011), sexual behavior (Capaldi, Stoolmiller, Clark, & Owen, 2002; Hipwell, Keenan, Loeber, & Battista, 2010), antisocial behavior or offending (Fergusson & Horwood, 1996; Lynne, 2011), and physical aggression (Martino, Ellickson, Klein, McCaffrey, & Edelen, 2008). One explanation is deviancy training, whereby at-risk youth reinforce one another's antisocial behaviors by talking about rule-breaking and responding to such deviant talk with attention and laughter (Dishion, Spracklen, Andrews, & Patterson, 1996). Indeed, deviancy training has been tied to problematic behaviors such as violence (Capaldi, Dishion, Stoolmiller, & Yoerger, 2001; Dishion, Véronneau, & Myers, 2010), antisocial or delinquent behavior (Poulin, Dishion, & Burraston, 2001; Snyder et al., 2010), and substance use (Dishion et al., 1995; Poulin et al., 2001). In terms of driving risk, susceptibility to peer pressure and friends' support of drinking predict high-risk driving (Shope, Raghunathan, & Patil, 2003), and there is some evidence that having risky friends is associated with risky driving, speeding, and crashes/near crashes in novice teen drivers (Simons-Morton et al., 2011; Simons-Morton et al., 2012).

Furthermore, adolescents with ADHD report more affiliation with deviant peers than do comparison adolescents, and some evidence suggests that deviant peer affiliation accounts

for much of the association between ADHD and smoking activity, perhaps especially for girls (Laucht, Hohm, Esser, Schmidt, & Becker, 2007). Similarly, self-reported deviant peer affiliation has been found to mediate the association between ADHD and substance use in a predominantly male (94%) sample (Marshall et al., 2003). Although the associations among ADHD symptoms, deviant peer affiliation, and driving risk have not been directly examined, this work suggests that ADHD symptoms in adolescent girls may predict and/or interact with deviant peer affiliation, resulting in increased driving risk.

Our overall goal was to examine the ability of perceived deviant peer affiliation to explain or change the putative association between ADHD symptoms (inattention and hyperactivity/impulsivity) and driving risk (accidents, citations, and illegal driving) in females with and without ADHD. As noted above, there is strong evidence of a predictive relation between ADHD and driving behavior, but we are not aware of any investigations of perceived deviant peer affiliation as a mediator or moderator of this association. Additionally, we do not know of any longitudinal investigations of the association between ADHD symptoms and later driving behavior in a large clinical sample of girls. Some investigations have examined sex differences or included sex as a covariate, with some studies showing similar rates of driving risk (e.g., Barkley et al., 2002) and others suggesting somewhat lowered risk for females (e.g., Reimer et al., 2005; Rosenbloom & Wultz, 2011). One epidemiological study investigated gender-specific associations between ADHD symptomatology and driving behavior, but this study did not examine ADHD symptom domains separately (Nada-Raja et al., 2007). We examine two divergent hypotheses regarding the association between ADHD symptoms, perceived deviant peer affiliation, and driving risk in females with and without ADHD: (H1) adolescent perceived deviant peer affiliation will mediate the association between adolescent ADHD symptoms and young adult driving risk, and (H2) adolescent perceived deviant peer affiliation will moderate the association between adolescent ADHD symptoms and young adult driving risk, such that those with high ADHD symptoms and high perceived deviant peer affiliation will be at greatest risk. Because there is strong evidence of comorbidity between ADHD and ODD/CD in girls (e.g., Biederman et al., 1999; Hinshaw, 2002), and because of the association between conduct problems and delinquent peer affiliation (e.g., Button et al., 2007), we control for adolescent ODD/CD as well as participant age.

Method

Procedure

We utilize data from a 10-year longitudinal study of behavioral, neuropsychological, social, and family functioning in 228 girls with and without ADHD (see Hinshaw et al., 2012). Three waves of data were collected: baseline/childhood (Wave 1; ages 6–12 years; $M = 9.6$ years), adolescence (Wave 2; ages 11–18 years, $M = 14.1$ years), and young adulthood (Wave 3; ages 17–24 years, $M = 19.6$ years). In childhood, girls participated in naturalistic summer camps during which multi-informant, multi-method data on symptoms and functional impairment were collected. Prospective follow-up evaluations in adolescence and young adulthood each consisted of two half-day clinic-based assessments with the participant and her parent(s). When clinic participation was not possible, we performed home visits or telephone interviews. Measured domains of impairment included academic, social, occupational, and neuropsychological functioning, as well as multiple domains of risk taking (sexual behavior, driving behavior, substance use). Baseline and follow-up assessments were conducted by highly trained B.A.-level research staff and graduate students in clinical psychology. Parent consent and participant assent/consent were collected at each wave of data collection. The summer camps and follow-up assessments received full University approval. See Hinshaw (2002) for more details regarding baseline procedures and participant characteristics.

Participants

At baseline, girls with ADHD ($n=140$) and comparison girls ($n=88$) were recruited with a multi-gated approach through pediatricians, schools, mental health centers, and direct advertisement in the San Francisco Bay Area. Families who responded to advertisements were rigorously screened for study participation. Entry criteria for girls with ADHD included meeting full criteria for ADHD through the parent Diagnostic Interview Schedule for Children (4th ed. [DISC-IV]; Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000). Common comorbidities were allowed: at baseline, 63% of the girls with ADHD also had ODD, 21% had CD, 27% had an anxiety disorder, and 12% had a reading disorder. Of the girls with ADHD, 93 met criteria for combined-type (ADHD-C) and 47 met criteria for predominantly inattentive type (ADHD-I). Comparison girls could not meet diagnostic criteria for ADHD and were matched to the ADHD sample at the group level with respect to age and ethnicity at baseline. Exclusion criteria for all girls were mental retardation, psychosis, overt neurological disorder, pervasive developmental disorder, lack of English spoken in the home, and medical problems prohibiting summer camp participation. The final sample was ethnically (53% White, 27% African American, 11% Latina, 9% Asian American) and socioeconomically diverse (public assistance to upper-middle class).

Approximately five years following summer camp participation, 209 of the 228 participants (92%) were retained for follow-up evaluations. There were no statistically significant differences between those retained and those lost to attrition for 29 of 31 baseline demographic and psychiatric variables; those lost to attrition had higher baseline scores of medium effect size for internalizing symptoms and were more likely to be from single-parent families (Hinshaw, Owens, Sami, & Fargeon, 2006). During the 10-year follow-up assessments, 216 of the original 228 girls (95%) were retained with at least some individual and family outcome measures. There were no differences between those retained at the 10-year follow-up and those lost to attrition on 18 of 23 demographic, psychiatric, and functional variables. The non-retained sample had lower family incomes, lower Full-Scale IQ scores, and higher teacher-rated ADHD, externalizing, and internalizing symptoms at baseline (Hinshaw et al., 2012). Of the retained sample, we utilize data from a total of 103 participants who had complete data for the measures examined in this investigation. Fifty-two percent of the utilized sample was in the ADHD group at Wave 1, and 26% of the sample had taken stimulant medication at some point between Wave 2 and Wave 3.

Measures

Swanson, Nolan, and Pelham Rating Scale— 4th edition (SNAP-IV; Swanson, 1992)—The SNAP-IV is a widely-used measure in ADHD assessment and treatment research (e.g., MTA Cooperative Group, 1999). We used the 39-item version of this rating scale, which includes the 18 *DSM-IV* symptoms of ADHD (9 symptoms of Hyperactivity/Impulsivity and 9 symptoms of Inattention). Symptoms were scored on 4-point metric that ranges from 0 (not at all present) to 3 (very much present). Parents (usually mothers) and teachers were asked to complete the SNAP-IV, reporting on unmedicated behavior of the girls, at each of the waves of data collection. For the present investigation, average mother and teacher ratings at Wave 2 (adolescence) for inattention items and for hyperactivity/impulsivity items are utilized as predictor variables. For those girls without valid teacher SNAP-IV data ($n = 28$) we utilize mother data only. We investigate the inattentive (IA) and hyperactive/impulsive (HI) domains separately because of the potentially unique contributions of these behaviors to driving behavior (e.g., Garner et al., 2012; Thompson et al., 2007). The parent-rated SNAP-IV has been shown to have good to excellent internal consistency with a sample of elementary school children ($n = 1,613$; Parent: IA $\alpha = .90$; HI $\alpha = .79$; Teacher: HI $\alpha = .96$; IA $\alpha = .92$); SNAP-IV scales predict probability of ADHD-related concerns and diagnosis (Bussing et al., 2008). In the current sample, internal

consistency was excellent (Mother: IA $\alpha = .96$; HI $\alpha = .91$; Teacher: IA $\alpha = .94$; HI $\alpha = .92$). Mother and teacher ratings were moderately correlated (IA: $r = .49$, $p < .001$; HI: $r = .35$, $p = .002$).

Social Relationships Interview (SRI)—The SRI is a measure developed for this investigation that consists of questions about romantic relationships, sexual behavior, and friendship group characteristics. It was administered to participants in adolescence and young adulthood by female staff. Questions regarding deviant peer behavior at Wave 2 (adolescence) based on the Peer Delinquency Scale (PDS; Loeber, Farrington, Stouthamer-Loeber, & van Kammen, 1998) are utilized in this investigation. The PDS had good internal consistency in an ethnically diverse sample of elementary school boys ($\alpha = .79$; Fite, Wynn, & Pardini, 2009). Each participant was asked to rate the proportion of her friends (0 = none; 1 = a few; 2 = half; 3 = most; 4 = all) who had engaged in specific delinquent behaviors in the last six months. These behaviors include skipping school, lying/disobeying/talking back, destroying property, stealing items of various dollar amounts, breaking and entering, joy-riding, hitting others, attacking others physically, using a weapon, selling drugs, using alcohol, using marijuana, and using hard drugs (Cronbach's $\alpha = .95$). We created a composite score from the mean of these items. Girls who responded “don't know” to more than 50% of the items were excluded ($n = 3$). Importantly, the SRI measures *perceived* deviant peer affiliation.

Driving Behavior Questionnaire (DBQ)—This measure is a version based on Barkley et al. (1996) that assesses risky driving behavior and negative driving outcomes rather than driving errors or attentional lapses. A similar version of this questionnaire was employed by the MTA Study (Molina et al., 2009). The DBQ was administered separately to young adults and their primary caregivers (overwhelmingly mothers) at Wave 3. We use self-report data, given the age of the sample and evidence that self-report of driving outcomes is generally consistent with official driving records (Barkley et al., 1996; Barkley et al., 2002). Items included in this investigation are: number of accidents when driving, number of citations, and ever having driven illegally (dichotomous: yes/no). For number of citations, we include only citations for moving vehicle citations (excluding citations for parking and paperwork violations). The variable that measures illegal driving is composed of several forms of illegal driving (e.g., driving without a license; driving in violation of learner's permit rules). We considered a measure of license suspensions but ultimately excluded it because of very low base rates. Each participant who completed this questionnaire at Wave 3 was old enough to have a learner's permit or license, and only those who had been licensed by Wave 3 ($n = 121$) were eligible for inclusion in the following analyses.

Covariates—We control for key potentially confounding factors in all analyses, including participant age at Wave 1 and ODD/CD diagnostic status at Wave 2. ODD/CD diagnostic status was ascertained from parental DISC-IV (Shaffer et al., 2000) data; it is included as a covariate in order to determine the independent effects of ADHD and perceived deviant peer affiliation on driving outcomes not accounted for by such behavior. This variable was coded as 1 if the adolescent met criteria for an ODD or CD diagnosis within the last year, and 0 if she did not.

Results

Data Analytic Plan

We first conducted zero-order correlations to determine the associations between our predictor, mediator, and outcome variables. We tested mediation hypotheses via bootstrap procedures (Shrout & Bolger, 2002) utilizing freely available software developed by

Preacher and Hayes (INDIRECT; 2008), with 10,000 bootstrap samples and 95% bias-corrected and accelerated confidence intervals (CI). Mediated effects were considered significant if the CI did not contain zero (Shrout & Bolger, 2002). Separate mediation models were tested utilizing each ADHD symptom domain (IA or HI) as a predictor of each driving outcome. All models included the covariates presented above, which functioned as statistical controls of both the mediator and outcome variables. Moderation hypotheses were tested via hierarchical multiple regression analyses utilizing freely available software developed by Preacher, Rucker, and Hayes (MODPROBE; 2007). For each regression, all covariates, the focal predictor (IA or HI) and the putative moderator (perceived deviant peer affiliation) were entered simultaneously on the first step. The interaction term (IA or HI $\times$ perceived deviant peer affiliation) was entered on the second step, and the ΔR^2 was examined for statistical significance.

Zero-Order Correlations

We initially standardized all continuous variables and winsorized outliers at ± 3.29 ($p < 0.001$; Tabachnick & Fidell, 2001) with ordering preserved. See Table 1 for descriptive statistics, presented for unwinsorized data for ease of interpretation, as well as zero-order correlations among winsorized variables for all girls. IA and HI were highly associated but still shared only about half of their variance with each other. Accordingly, and related to the theoretical reasons noted above, these two symptom domains were examined separately as predictors. Perceived deviant peer affiliation (DP) was marginally associated with IA ($p = 0.050$), but not with HI. Number of citations and number of accidents were modestly associated, but neither of these variables was associated with having driven illegally, suggesting that each outcome variable measures a relatively distinct construct. IA and perceived deviant peer affiliation were both significantly associated with number of accidents and number of citations. HI was not associated with any type of driving risk.

Mediation Analyses¹

Number of accidents—After controlling for covariates, we found no direct effect of IA ($b = 0.13$, $p = .158$) or HI ($b = 0.09$, $p = .280$) on number of accidents. There was a direct effect of DP on number of accidents (IA: $b = 0.24$, $p = .005$; HI: $b = 0.25$, $p = .003$). Assessment of the indirect effects based on bootstrap procedures revealed that the 95% CI did not contain zero for the effect of IA via DP ($b = 0.04$, $CI_{95} = 0.002, 0.178$; see Table 2), indicating significant mediation. Correlation analyses verified that each individual pathway of this effect was in the expected direction. Thus, those participants with more inattention affiliated with more perceived deviant peers, and in turn, got into more accidents. The indirect effect for HI was not significant ($b = 0.01$, $CI_{95} = -0.019, 0.129$; see Table 2).

Number of citations—After controlling for covariates, there was a significant direct effect of IA ($b = 0.16$, $p = .031$) on number of citations, but no direct effect of HI ($b = 0.07$, $p = .327$). There was a significant direct effect of DP (IA: $b = 0.19$, $p = .005$; HI: $b = 0.21$, $p = .003$). There was also a significant indirect effect of IA on number of citations via perceived deviant peer affiliation ($b = 0.04$, $CI_{95} = 0.0002, 0.1302$; see Table 2). Examination of correlation analyses verified that those with more inattention affiliated with

¹We also conducted exploratory analyses to determine the independent contribution of each symptom dimension to driving risk. For mediation models, when controlling for IA in HI analyses and HI in IA analyses, all significant direct effects remained significant, but there were no indirect effects. Although it is possible that neither symptom dimension independently contributes to indirect effects on driving risk via deviant peer affiliation, the lack of significant findings may well relate to the substantial overlap in these symptom clusters ($r = .72$), which may result in overcontrol (see Miller & Chapman, 2001, for discussion of this issue), as well as lack of power. For moderation models, all significant results remained significant when controlling for IA in HI analyses and when controlling for HI in IA analyses.

more perceived deviant peers and thus had more moving vehicle citations. The indirect effect for HI was not significant ($b = 0.01$, $CI_{95} = -0.019, 0.105$; see Table 2).

Illegal Driving—After controlling for covariates, there were no direct (IA: $b = 0.11$, Wald = 0.16 $p = .686$; HI: $b = 0.16$, Wald = 0.35, $p = .554$) or indirect (IA: $b = 0.17$, $CI_{95} = -0.017, 0.499$; HI: $b = 0.08$, $CI_{95} = -0.108, 0.506$; see Table 2) effects of IA or HI on illegal driving. Again, there was a direct effect of DP on illegal driving (IA: $b = 0.84$, Wald = 9.08 $p = .003$; HI: $b = 0.85$, Wald = 9.29, $p = .002$).

Moderation Analyses

Number of accidents—In the regression examining predictive effects of adolescent IA, the main effect of IA was not significant ($b = 0.12$, $p = .176$), and the main effect of DP was significant ($b = 0.27$, $p = .004$). The inclusion of the IA $\times$ DP interaction did not result in a significantly greater proportion of explained variance in number of accidents ($\Delta R^2 = 0.01$, $b = -0.07$, $p = .403$). In the regression examining HI, there was a significant main effect of DP ($b = 0.28$, $p < .001$) and a significant interaction of HI $\times$ DP ($\Delta R^2 = 0.06$, $b = -0.16$, $p = .009$), but no main effect of HI ($b = 0.12$, $p = .143$). Examination of the simple slopes indicated that the positive association between HI and number of accidents was limited to those participants who reported low deviant peer affiliation ($b = 0.27$, $p = 0.012$; see Figure 1).

Number of citations—In the regression examining predictive effects of IA, the main effect for IA was significant ($b = 0.16$, $p = .023$), whereas the main effect of DP approached significance ($b = 0.14$, $p = .069$). In the regression examining HI, the main effect for HI was not significant ($b = 0.06$, $p = .389$), and the main effect of DP was significant ($b = 0.20$, $p = .004$). The interaction terms for both models were not significant (all p s > 0.10).

Illegal Driving—In the regressions examining IA and HI, only the effect of DP (IA: $b = 0.85$, Wald = 8.13, $p = .004$; HI: $b = 0.92$, Wald = 8.52, $p = .004$) was significant. Main effects of symptoms and interactions between symptoms and DP were not significant (p s > 0.10).

Discussion

Our core goal was to examine the role of adolescent girls' perceived deviant peer affiliation in the association between ADHD symptoms in adolescence and driving risk in young adulthood. We found a direct association between inattention and moving vehicle citations, but no other direct effects of ADHD symptoms on driving risk in the presence of statistical controls. In addition, we found modest but significant indirect pathways from inattention to (a) accidents and (b) moving vehicle citations via perceived deviant peer affiliation. Consistent with other research on ADHD, these results suggest that the pathway from individual risk to peer context to individual behavior may be an important component of risky behavior (e.g., Marshal et al., 2003). It appears that this pathway may be especially salient for those with symptoms of inattention. Furthermore, we found an interaction between hyperactivity/impulsivity and perceived deviant peer affiliation, whereby this symptom domain was positively predictive of accidents, but only for girls with low perceived deviant peer affiliation. Contrary to our expectations, risk of accidents was not predicted by hyperactivity/impulsivity in girls with average or high perceived deviant peer affiliation; amongst these participants, variability in outcome was explained only by perceived deviant peer affiliation.

The pathway from inattention to negative driving outcomes through deviant peer affiliation is consistent with other work in which deviant peer affiliation mediated the association between inattention and substance use, especially for those with high ODD and CD symptoms (Marshall & Molina, 2006). One possible explanation is that inattention may be particularly important in predicting certain aspects of difficulty in normative peer interactions (e.g., Maedgen & Carlson, 2000) and thus may lead to affiliation with a deviant peer group that encourages risky behavior. Some research has also shown that inattention is uniquely associated with executive dysfunction (e.g., Chhabildas, Pennington, & Willcutt, 2001), which may increase the likelihood of academic difficulties that predict deviant peer affiliation (Biederman et al., 2004; Dishion, Patterson, Stoolmiller, & Skinner, 1991). Likewise, executive dysfunction may contribute to the significant direct association between inattention and moving vehicle citations in this sample.

The importance of deviant peers is evidenced by the consistent positive associations observed between perceived deviant peer affiliation and driving risk across mediator and moderator analyses. Importantly, predictions from perceived deviant peer affiliation to risky driving appear to exist independently of ADHD symptomatology and to be more robust. Several explanations for the role of deviant peers in predicting future risk taking are possible. For instance, deviant peers may reinforce risky driving behaviors and/or other behaviors that predict problematic driving outcomes, such as substance use (Shope, Waller, Raghunathan, & Patil, 2001). Alternatively, deviant peers may encourage risky driving directly through their presence in the car with the young adult driver. Peer presence increases risky driving for adolescents (e.g., Allen & Brown, 2008), an effect that may extend to young adults and be compounded by the presence of peers who are especially deviant. Another plausible explanation is that perceived deviant peer affiliation as measured in this study is a proxy for individual-level risk-taking behavior. Although we did control for ODD/CD diagnosis, we did not control for adolescent deviant behavior per se. Future research efforts should investigate the association between deviant peer affiliation and driving behavior both concurrently and prospectively, including careful examination of additional covariates such as the participant's own deviant behaviors. Experimental studies of the role of deviant peers in encouraging risky driving will be crucial in increasing our understanding of this process.

Many creative interventions address the association between ADHD symptoms and driving behavior. For example, in addition to promising investigations of the effects of ADHD medications on driving performance (e.g., Barkley, Anderson, & Kruesi, 2007; Barkley, Murphy, O'Connell, & Connor, 2005; Biederman et al., 2012; Cox et al., 2012; Kay, Michaels, & Pakull, 2009; Verster et al., 2008), experimental interventions have focused on the effects of manual versus automatic transmission (Cox et al., 2006), GPS vehicle tracking with associated incentives and disincentives (Markham, Porter, & Ball, 2011), and multi-component psychosocial treatment (Fabiano et al., 2011). Although ADHD symptoms are important targets for intervention efforts, the influence of peers should not be neglected in creating interventions. Graduated licensing laws have limited the presence of peers with young novice drivers and appear to be effective (e.g., Fell, Todd, & Voas, 2011), but relatively less attention has been paid to the influence of deviant peer context.

Despite the strengths of this study, several limitations are noteworthy. First, although we controlled for age, we did not investigate the potentially confounding effect of driving exposure. As noted by Barkley and Cox (2007), if individuals with ADHD have more driving exposure compared to their same-age peers or vice-versa, this factor could account for driving behaviors (see Fischer et al., 2007; Woodward et al., 2000). Still, in this sample, inattention and hyperactivity/impulsivity were not correlated with months licensed or miles driven per week (all p s > 0.1). Second, we were unable to control for the effect of stimulant

medication, as our sample did not report on patterns of medication use throughout development with sufficient sensitivity. It is possible that the general lack of direct associations between ADHD symptoms and driving risk is a consequence. Additionally, the independent contribution of each ADHD symptom dimension was not a focus of this study, but should be explored in future longitudinal studies. The strong association between inattention and hyperactivity/impulsivity and related concerns regarding overcontrol (Miller & Chapman, 2001) present a significant challenge that may be redressed only with larger samples.

Furthermore, because we collected data regarding perceived deviant peer affiliation and young adult driving risk from participants, it is possible that associations between these variables are related to shared method variance and/or reporter bias. Sociometric data could be used to form a more complete picture of each participant's social context, although collecting peer sociometrics in adolescence is a daunting challenge. Similarly, it will be important to conduct additional large longitudinal investigations with girls that employ official driving records, observer report, and/or simulator data. We considered inclusion of parent-report driving data in this investigation, but elected against this option given the age of the sample and evidence of accurate self-report of driving outcomes (Barkley et al., 1996; Barkley et al., 2002). Larger clinical and community-based samples will help to disentangle this information. Additionally, the inclusion of both female and male participants will allow for further investigation of sex differences in both prediction of risky driving and treatment (e.g., Mikami et al., 2009; Nada-Raja et al., 2007; Woodward et al., 2000). Indeed, our findings may not generalize to boys with ADHD or to non-clinical populations.

Finally, no claims regarding causality can be made. We measured ADHD symptoms and deviant peer affiliation concurrently, and although driving outcomes were measured prospectively and statistical mediation and moderation were established, the direction of the symptom-deviant peer affiliation link cannot be confirmed. Additional studies utilizing multiple time points and appropriate statistical controls are needed to further investigate the potentially complex associations between ADHD symptoms, peers, and driving risk.

In sum, we examined the ability of perceived deviant peer affiliation to explain or influence the association between ADHD symptoms and driving risk in young women with and without ADHD, finding modest evidence of both moderation and mediation. These findings lend evidence to a large body of research on the association between ADHD and driving-related risk and extend this work by exploring the influence of perceived deviant peer affiliation in a sample of females with and without ADHD. These data have implications for intervention efforts and public policy, and provide initial evidence that both peer-contextual risk and individual-level risk should be considered in interventions designed to reduce risky driving in those with and without ADHD.

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Figure 1.

Number of accidents as a function of hyperactivity/impulsivity for girls with varying degrees of perceived deviant peer affiliation.

Note: Variables are standardized and winsorized.

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

Table 1

Descriptive Statistics and Zero-Order Correlations for Study Variables.

Variable	1	2	3	4	5	6	7	M	SD	Min	Max	Freq.
<i>Covariates</i>												
1. Age	--							118.67	19.67	80	161	--
2. ODD/CD	.09	--						.31	.47	0	1	--
<i>Adolescent Predictors</i>												
3. Inattention	.14	.50***	--					0.92	0.72	0.00	2.67	--
4. Hyper./Impulsivity	-.05	.40***	.72***	--				0.43	0.50	0.00	2.06	--
5. Perceived Dev. Peers	.37***	.05	.19 [†]	.06	--			0.48	0.58	0.00	2.67	--
<i>Young Adult Outcomes</i>												
6. Number of Accidents	.22*	.04	.20*	.11	.36***	--		0.93	1.55	0	9	49%
7. Number of Citations	.23*	.11	.29**	.13	.36***	.23*	--	0.75	1.62	0	11	34%
8. Illegal Driving	-.39***	-.08	.00	.07	.14	-.06	.05	0.50	0.50	0	1	50%

Notes: N = 103. Descriptive statistics are presented as unwinorized values for ease of interpretation. Age = age in months at Wave 1 (baseline). ODD/CD and Illegal Driving are dichotomous variables. Freq. = percentage of young adults with a score greater than 0 for each of the driving variables.

[†] p < 0.055,
 * p < .05,
 ** p < .01,
 *** p < .001

Table 2

Mediation Analyses: Indirect Effects.

Indirect Effect Pathway	Bootstrap Estimate	95% Confidence Interval
IA→DP→Accidents	0.04	[0.002, 0.178]
IA→DP→Citations	0.04	[0.0002, 0.1302]
IA→DP→Illegal Driving	0.17	[−0.017, 0.499]
HI→DP→Accidents	0.01	[−0.019, 0.129]
HI→DP→Citations	0.01	[−0.019, 0.105]
HI→DP→Illegal Driving	0.08	[−0.108, 0.506]

Notes: $N = 103$. Mediated effects are considered significant if the CI does not contain zero. IA = inattention; HI = hyperactivity/impulsivity; DP = perceived deviant peer affiliation. Illegal Driving is a dichotomous outcome variable.