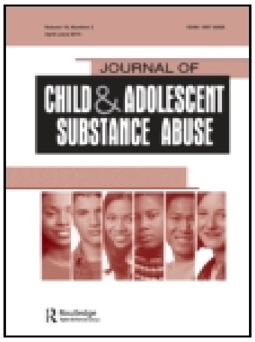

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Attention Deficit/Hyperactivity Disorder (ADHD) Symptoms Predict Alcohol Expectancy Development

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ABSTRACT

Objective: Positive alcohol expectancies and attention deficit/hyperactivity disorder (ADHD) are independent risk factors for adolescent alcohol problems and substance use disorders. However, the association of early ADHD diagnostic status, as well as its separate dimensions of inattention and hyperactivity, with alcohol expectancies is essentially unknown. *Method*: At baseline (i.e., Wave 1), parents of 139 6- to 9-year-old children (71% male) with ($N = 77$; 55%) and without ($N = 62$; 45%) ADHD completed structured diagnostic interviews of child psychopathology. Approximately two years later (i.e., Wave 2), children completed a Memory Model-Based Expectancy Questionnaire (MMBEQ) to ascertain their positive and negative expectancies regarding alcohol use. All children were alcohol naïve at both baseline and follow-up assessments. *Results*: Controlling for age, sex, IQ, as well as the number of Wave 1 oppositional defiant disorder (ODD) and conduct disorder (CD) symptoms, the number of baseline hyperactivity symptoms prospectively predicted more positive arousing (i.e., MMBEQ "wild and crazy" subscale) alcohol expectancies at Wave 2. No predictive association was observed for the number of Wave 1 inattention symptoms and alcohol expectancies. *Conclusions*: Childhood hyperactivity prospectively and positively predicted expectancies regarding the arousing properties of alcohol, independent of inattention and ODD/CD symptoms, as well as other key covariates. Even in the absence of explicit alcohol engagement, youths with elevated hyperactivity may benefit from targeted intervention given its association with more positive arousing alcohol expectancies.

KEYWORDS
ADHD; alcohol; expectancies; hyperactivity; impulsivity

Introduction

Alcohol use initiation

Alcohol is the most commonly used substance during adolescence, with a third of high school seniors having ever tried alcohol and almost a fifth of all twelfth graders having engaged in heavy episodic drinking (i.e., five or more drinks on one occasion during the past two weeks; Johnston, O'Malley, Miech, Bachman, & Schulenberg, 2015). Among adolescents, heavy episodic drinking is the most common pattern of alcohol use and poses a significant public health concern given its association with increased risky behaviors such as drunk driving, riding with impaired drivers, violence, unsafe sex, and other substance use (Miller, Naimi, Brewer, & Jones, 2007). In addition, alcohol and substance use disorders (as defined by the *Diagnostic and Statistical Manual of Mental Disorders*-IV [DSM]; American Psychiatric Association, 2000) often emerge during adolescence, with 5% of youths ages 12 to 17 meeting diagnostic criteria for an alcohol use disorder (Substance Abuse and Mental Health Services Administration Office of Applied Studies, 2008). Despite its clinical and public health significance, relatively little is known about factors that precede early alcohol use. Given that temporal ordering is necessary to differentiate risk factors from simple correlates (Kraemer, Stice, Kazdin, Offord, & Kupfer, 2001), prospective longitudinal studies are well-positioned to identify risk factors that are logical targets for alcohol use intervention and prevention programs.

Association of childhood ADHD and alcohol use

One potential risk factor for alcohol problems is childhood attention deficit/hyperactivity disorder (ADHD). Characterized by an early onset of pervasive and impairing levels of inattention and/or hyperactivity, ADHD affects approximately five million 3- to 17-year-old children (8%) in the United States (Bloom, Cohen, & Freeman, 2011). ADHD has demonstrated robust predictive

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validity given its reliable association with elevated comorbidity across behavioral (e.g., oppositional defiant, conduct) and affective (e.g., depression, anxiety) disorders and prospective prediction of functional impairment, including peer rejection and substandard academic achievement (Biederman, Petty, Clarke, Lomedico, & Faraone, 2011; Lee, Lahey, Owens, & Hinshaw, 2008; Owens, Hinshaw, Lee, & Lahey, 2009). Thus, early ADHD is associated with a widely dispersed and persistent pattern of future academic, socioemotional, behavioral, and occupational dysfunction, even when ADHD symptoms themselves remit (Lee et al., 2008; Minkoff, 2009).

There is emerging consensus that early ADHD is a risk factor for adolescent and adult alcohol and substance use and abuse (Glantz et al., 2009). Two recent independent meta-analyses of prospective longitudinal studies both suggested that ADHD probands were nearly 50% more likely to engage in alcohol use (Charach, Yeung, Climans, & Lillie, 2011) and to be diagnosed with alcohol abuse/dependence (Lee, Humphreys, Flory, Liu, & Glass, 2011) relative to non-ADHD youths. Similar associations between ADHD and alcohol and substance use disorders have also been observed in adults, with 11% of individuals with alcohol dependence having met diagnostic criteria for ADHD and 25% of adults with any substance use disorder having comorbid ADHD (Kessler et al., 2006). ADHD consists of individual differences in inattention and hyperactivity/impulsivity. Despite their covariation, these subtypes are empirically distinct; thus, predictions from early ADHD must separately parse apart the unique association of inattention and hyperactivity with respect to key outcomes. Previous evidence suggests that inattention and hyperactivity may differentially relate to alcohol use outcomes: whereas Molina and Pelham (2003) found that inattention problems were uniquely (controlling for hyperactivity) associated with alcohol problems, Lee and Hinshaw (2006) found that childhood hyperactivity (controlling for inattention) prospectively predicted alcohol/substance problems in a large sample of girls. To improve traction on which specific ADHD dimension may be associated with alcohol expectancies, inattention and hyperactivity were examined separately.

Disruptive behavior disorders, including oppositional defiant disorder (ODD) and conduct disorder (CD), frequently co-occur with ADHD (Biederman, 2005; Gau et al., 2010), and they, too, positively predict critical substance use outcomes (Charach et al., 2011). Whereas ODD is the most common comorbid disorder with ADHD, affecting as many as 60% of youths with ADHD, CD occurs in approximately 20% of youths with ADHD (Biederman, 2005). Notably, previous studies of ADHD and alcohol and substance outcomes have frequently ignored co-occurring ODD/CD, complicating inferences about the predictive validity of childhood ADHD with respect to subsequent alcohol and substance outcomes. To improve the specificity of the predictive validity of ADHD for positive and negative alcohol expectancies, the current study rigorously and conservatively accounted for both comorbid ODD and CD.

Association of alcohol expectancies and alcohol use

To more intensively characterize potential processes underlying the development of alcohol problems, the identification of intermediate phenotypes prior to explicit alcohol and substance use is an important priority, particularly using developmental theory and developmentally sensitive designs (Connor et al., 2008; Hendershot et al., 2009). One promising construct consists of individual differences in children's expectations about the behavioral effects of alcohol (Chartier, Hesselbrock, & Hesselbrock, 2010). For example, adolescents who expected that alcohol use would produce more pleasurable experiences (e.g., increased socialization, improved motor and cognitive functioning, sexual enhancement) were more likely to use alcohol than youths who believed that alcohol would have negative effects (Brown, Christiansen, & Goldman, 1987; Chartier et al., 2010). Although alcohol expectancies emerge early in development (i.e., preschool; Noll, Zucker, & Greenberg, 1990), one important developmental period for positive alcohol expectancies is between eight and 10 years of age (Hipwell et al., 2005; Miller, Smith, & Goldman, 1990), several years before the onset of experimentation with alcohol for most youths (Johnston et al., 2012). This period corresponds with several dynamic changes in cognition (Giedd & Rapoport, 2010), peer relationships, and a greater exposure to substance-using models (Chartier et al., 2010), perhaps contributing to the increased alcohol initiation that is characteristic of this developmental period. Typically, positive expectancies increase as children develop whereas negative expectancies decrease over time (Chartier et al., 2010), a developmental pattern that corresponds with the initiation of substance use (Sher, Grekin, & Williams, 2005).

Association of ADHD and alcohol expectancies

Alcohol expectancies are a plausible link between ADHD and the initiation of alcohol and substance use. Specifically, the acquired preparedness model of alcohol expectancies hypothesizes that greater disinhibition influences the formation of more positive alcohol expectancies, which in turn influences greater drinking behaviors (Smith & Anderson, 2001). Prospective studies have reliably shown that childhood and adolescent disinhibition is a risk factor for the development of alcohol-related disorders (Iacono, Carlson, Taylor, Elkins, & McGue, 1999; King et al., 2009; Rooney, Chronis-Tuscano, & Huggins, 2012; Sher, Bartholow, & Wood, 2000). Given the centrality of disinhibition to emergent positive alcohol expectancies and to prevailing causal theories of ADHD (Barkley, 1997; Nigg, 2001; Nigg & Casey, 2005), positive alcohol expectancies may partially mediate the association of ADHD specifically, and perhaps disinhibition more generally, with respect to alcohol use. Thus, the association of early ADHD and alcohol expectancy formation may represent one important pathway in the development of alcohol-related problems and disorders.

The Memory Model-Based Expectancy Questionnaire (Dunn, 1999; Dunn & Goldman, 1996) was used in this study as an explicit alcohol expectancy measure. This measure is based upon multidimensional scaling to generate a model of an associational network of expectancies (Rather, Goldman, Roehrich, & Brannick, 1992) and consists of four factors, including positive-social, negative arousal, sedated/impaired, and wild/crazy. These four domains had been shown to represent the full alcohol expectancy semantic network, and are active during this developmental period (Dunn, 1999; Dunn & Goldman, 1996). Wild/crazy expectancies in particular have been associated with greater alcohol use (Gunn & Smith, 2010), as well as with earlier drinker status and problematic behaviors in fifth graders (Fischer, Settles, Collins, Gunn, & Smith, 2012), making it a particularly interesting variable to examine.

In sum, although ADHD and positive alcohol expectancies are each individually implicated as risk factors for the initiation of future alcohol use, their association with each other has not been explicitly evaluated in children. The relationship between ADHD and alcohol expectancy formation may represent one important pathway in the development of alcohol-related problems and disorders, and could provide important information for targeted interventions. Therefore, we tested the independent and prospective association of baseline (i.e., Wave 1) ADHD symptoms (i.e., separate counts of inattention and hyperactivity symptoms) with individual differences in alcohol expectancies, assessed at a two-year prospective follow-up (i.e., Wave 2) in an ethnically diverse community sample of 139 children, controlling for the number of Wave 1 ODD and CD symptoms. We hypothesized that Wave 1 ADHD symptoms would positively predict future positive and arousing alcohol expectancies as well as inversely predict negative alcohol expectancies. Specifically, given the central role of disinhibition to ADHD, alcohol expectancies, and alcohol-spectrum phenotypes (Smith & Anderson, 2001), we hypothesized that Wave 1 hyperactivity would uniquely predict emergent Wave 2 alcohol expectancies beyond key covariates.

Method

Participants

Participants were 139 6- to 9-year-old children (M = 7.37, SD = 1.10; 71% male) with (N = 77; 56%) and without (N = 62; 44%) DSM-IV ADHD. Among the ADHD probands, 43% (N = 33) were diagnosed with Inattentive type, 13% (N = 10) with Hyperactive/Impulsive type, and 44% (N = 34) with Combined type. In the overall sample, 44% of the ADHD group and 13% of the non-ADHD group met diagnostic criteria for ODD in the past year whereas 4% and 0% met diagnostic criteria for CD in the past year among ADHD probands and non-ADHD comparison youths, respectively. The sample was ethnically diverse (50% Caucasian [N = 69], 22% mixed ethnicity [N = 31], 12% Hispanic [N = 16], 4% African-American [N = 6], 2% Asian [N = 3], and 10% unknown or missing [N = 14]; see Table 1). At baseline (i.e., Wave 1), participants were recruited from local schools, flyers posted in public locations, and referrals from local mental health and medical service providers in a large metropolitan city in the Western United States. Inclusion criteria for all participants included living with at least one biological parent at least half-time, being enrolled in school full-time, being fluent in English, and never having used alcohol but having an understanding of what alcohol was. At Wave 1 and 2, children were asked if they had ever had a full drink of alcohol; children who endorsed alcohol use greater than a sip were excluded (N = 6, not described in this article) so that any differences did not reflect the pharmacological effects of alcohol. Exclusion criteria included a full-scale IQ <70; an autism spectrum, seizure, or any neurological disorder; or a past-*month* Axis I disorder other than ADHD, ODD, CD, or specific phobia, as measured by the Diagnostic Interview Scale for Children-IV (DISC-IV; Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000). None of the parents in the sample met criteria for a current alcohol use disorder, based on the Structured Clinical Interview for DSM Disorders (First, Spitzer, Gibbon, & Williams, 2002).

Youth ADHD diagnostic status (i.e., ADHD versus non-ADHD comparison) was based on a positive diagnosis according to the DISC-IV (discussed later), which probed all requisite *DSM*-IV criteria including age of onset, cross-situational impairment, and duration. All participants were recruited, screened, and assessed using identical

Table 1. Demographic characteristics of participants.

	ADHD N = 77 M (SD)	Non-ADHD N = 62 M (SD)	χ2/p
Average age at Wave 1[a]	7.27 (1.14)	7.50 (1.04)	.23
Average age at Wave 2[b]	9.49 (1.26)	9.69 (1.25)	.35
% Male	78%	61%	.04*
% Caucasian	46%	52%	.43
Full-scale IQ	104.85 (13.40)	112.09 (16.16)	.01*
Total number of inattention symptoms	6.95 (1.86)	1.76 (1.89)	<.001*
Total number of hyperactivity/impulsivity symptoms	5.26 (2.70)	1.32 (1.70)	<.001*
Total number of ADHD symptoms	12.21 (3.04)	3.08 (2.95)	<.001*
Total number of ODD symptoms	3.16 (2.35)	1.02 (1.64)	<.001*
% ODD diagnosis	44%	13%	<.001*
Total number of CD symptoms	.61 (.83)	.24 (.50)	<.01*
MMBEQ: Positive-social	18.58 (8.19)	20.58 (8.09)	.15
MMBEQ: Negative arousal	13.13 (5.37)	11.85 (4.14)	.13
MMBEQ: Sedated/impaired	11.99 (4.40)	11.84 (3.44)	.83
MMBEQ: Wild/crazy	14.66 (4.11)	13.90 (3.93)	.27

Note. ADHD = Attention Deficit/Hyperactivity Disorder, ODD = Oppositional Defiant Disorder, CD = Conduct Disorder, MMBEQ = Memory Model-Based Expectancy Questionnaire.
[a]Age distribution at Wave 1: age 6 = 39, 28%; age 7 = 37, 27%; age 8 = 35, 25%; age 9 = 28, 20%. [b]Age distribution at Wave 2: age 8 = 31, 22%; age 9 = 42, 30%; age 10 = 30, 22%; age 11 = 26, 19%; age 12 = 9, 7%; age 13 = 1, <1%.
*$p < .05$.

procedures and measures. The Institutional Review Board approved all study procedures at Waves 1 and 2.

Procedures

At Wave 1 (ages 6 to 9), families who contacted the study completed a telephone screener to determine their eligibility based on the inclusion and exclusion criteria just listed. Eligible families were then invited to the research laboratory for in-person assessments. Following signed parental consent and child assent, extensively trained staff assessed children's cognitive, academic, and socio-emotional functioning, and parents completed the DISC-IV about their child's psychopathology. All interviewers were initially blind to the child's diagnostic status, although the blind could not always be maintained given the extensive information gathered about the child. Approximately 85% of children were unmedicated during the laboratory assessment. Parents were asked to rate each child based on his or her unmedicated behavior.

Approximately two years after their Wave 1 evaluation, families were invited back to the laboratory to participate in a follow-up study (i.e., Wave 2; ages 8 to 13) that consisted of highly parallel procedures to Wave 1 (e.g., structured diagnostic interviews), but also included the assessment of children's alcohol expectancies using the Memory Model-Based Expectancy Questionnaire (MMBEQ). Overall, at Wave 2 (ages 8 to 13), 91% of the total Wave 1 sample was ascertained with no significant differences between the overall Wave 2 sample versus participants who did not participate at Wave 2 based on the gender distribution, average age, or the number of ODD/CD symptoms. There was a marginally significant association with the number of ADHD symptoms where Wave 2 participants had significantly *more* ADHD symptoms [F (1, 224) = 4.117, $p < .05$] than families that did not participate in Wave 2.

Measures

Cognitive ability

Full-scale IQ was estimated at Wave 1 using four subtests of the Wechsler Intelligence Scale for Children-IV (WISC-IV): Digit Span, Vocabulary, Symbol Search, and Arithmetic subtests (Wechsler, 2003). This four subtest composite correlates at $r = .91$ with the full administration of the WISC-IV (Wechsler, 2003).

ADHD, ODD, and CD

ADHD, ODD, and CD were ascertained at Wave 1 and again at the Wave 2 follow-up using the DISC-IV (Shaffer et al., 2000), a fully structured *DSM*-IV diagnostic interview with the parent. In the *DSM*-IV field trials, test-retest reliability for ADHD from the DISC-IV ranged from .51 to .64 (Lahey et al., 1994). Given that the predictive validity of dimensional ratings of ADHD, ODD, and CD is superior to dichotomous designations (Fergusson & Horwood, 1995), we used the total number of Wave 1 ADHD symptoms as the independent variable, covarying for the total number of Wave 1 ODD and CD symptoms from the DISC-IV.

Alcohol expectancies

At Wave 2, children completed the 41-item MMBEQ (Dunn, 1999; Dunn & Goldman, 1996). Children were first read the definition of a single alcohol expectancy word (e.g., talkative, cool, sleepy, relaxed, etc.), and then reported how often people experience "the expectancy word" following alcohol consumption. Aided by a graphic anchor (i.e., rectangular boxes differentiated by different levels of being "filled"), children rated their expectancies according to a 4-point scale (i.e., never, sometimes, usually, always). The reliability of the MMBEQ has been established across development, with coefficient alphas of .76 for second to fifth graders, .81 for third, sixth, ninth, and twelfth graders, and .83 for college undergraduates (Dunn & Goldman, 1996, 1998). Four separable expectancy factors were derived: positive-social (e.g., happy, fun), negative arousal (e.g., mad, sad), sedated/impaired (e.g., sleepy, stupid), and wild/crazy (e.g., goofy, hyper). Cronbach's alphas for the subscales were adequate to good (positive-social = .82, negative arousal = .79, sedated/impaired = .70, wild/crazy = .77). Endorsement of all four scales increases over childhood, with the wild/crazy subscale showing the most stability between mid- to late-childhood (Bekman, Goldman, Worley, & Anderson, 2011). Moreover, there is a significant increase in positive alcohol expectancies between ages 8 and 11 (Hipwell et al., 2005; Miller et al., 1990), precisely within the age range of participants at Wave 2 (ages 8 to 13).

Data analysis

Correlations between predictors and outcome variables

Pearson's r correlations between all predictors and outcome variables are summarized in Table 2.

Wave 1 Inattention and hyperactivity predictions of wave 2 alcohol expectancies

To test the independent association of Wave 1 (ages 6 to 9) ADHD symptoms (i.e., separate counts of the total number of inattention and hyperactivity symptoms) with individual differences in Wave 2 (ages 8 to 13) alcohol expectancy subscales (i.e., positive-social, negative arousal, sedated/impaired, and wild/crazy), we constructed four separate hierarchical linear regressions. At Step 1, we controlled for age, sex, IQ, as well as the total number of Wave 1 ODD and CD symptoms (Table 2). The total number of ODD and CD symptoms were included as covariates to ensure findings reflected differences in the number of ADHD symptoms rather than influence of ODD or CD, thereby improving the specificity of the prediction. All predictors were centered at the sample mean (Aiken & West, 1991). Because Wave 1 inattention, hyperactivity, ODD, and CD symptoms were significantly skewed, logarithmic transformations were applied (Tabachnick & Fidell, 2007). Models were fit before and after inclusion of ADHD subscales to determine the unique amounts of variance captured by inattention and hyperactivity. At Step 2, we separately entered the total number of Wave 1 inattention and hyperactivity symptoms to disentangle their independent association with alcohol expectancies (Molina & Pelham, 2003). Type I error was set at $p < .05$ for the overall model.

Association of wave 2 ADHD symptoms with alcohol expectancies

We examined the *concurrent* association of Wave 2 (ages 8 to 13) ADHD symptoms with Wave 2 wild/crazy expectancies. Controlling for Wave 1 age, sex, IQ, as well as ODD and CD symptoms, we separately entered Wave

Table 2. Correlations between predictors and outcomes.

	1	2	3	4	5	6	7	8	9	10	11
1. Total number of hyperactivity/impulsivity symptoms	—	.54**	.60**	.37**	−.18*	−.21*	−.04	−.19*	.11	.00	.15
2. Total number of inattentive symptoms		—	.38**	.22**	.03	−.13	−.32**	−.13	.15	.04	.07
3. Total number of ODD symptoms			—	.40**	−.01	−.10	−.01	−.12	−.02	−.10	−.07
4. Total number of CD symptoms				—	−.15	−.05	−.08	−.06	.11	.11	−.09
5. Age at Wave 1					—	.05	−.07	.24**	.04	.11	−.04
6. Sex						—	−.19*	.16	.03	.05	.16
7. IQ							—	.02	−.13	−.12	−.08
8. MMBEQ: Positive-social								—	−.02	−.07	−.01
9. MMBEQ: Negative arousal									—	.57**	.52**
10. MMBEQ: Sedated/impaired										—	.55**
11. MMBEQ: Wild/crazy											—

Note. Hyperactivity/impulsivity symptoms = total symptoms endorsed for the attention deficit/hyperactivity disorder (ADHD) hyperactivity/impulsivity clusters on the Diagnostic Interview Schedule for Children—Fourth Edition (DISC-IV); Inattentive symptoms = total symptoms endorsed for the ADHD inattention cluster on the DISC-IV; ODD symptoms = total symptoms endorsed for oppositional defiant disorder on the DISC-IV; CD symptoms = total symptoms endorsed for conduct disorder on the DISC-IV; Sex coded: 1 Male, 2 Female; MMBEQ = Memory-Model Based Expectancy Questionnaire.
$^{*}p < .05$. $^{**}p < .01$.

2 (ages 8 to 13) inattention and hyperactivity symptom counts in predictions of alcohol expectancies.

Results

Correlations between predictors and outcome variables

A correlation matrix of all predictor and outcome variables is presented in Table 2. Consistent with the literature (Dunn & Goldman, 1998; Jones, Corbin, & Fromme, 2001), there was a positive correlation between Wave 1 age and Wave 2 positive-social expectancies (i.e., older children had more positive expectancies regarding alcohol use). As expected, although the total number of Wave 1 inattention and hyperactivity symptoms was positively and significantly correlated, the magnitude did not suggest redundancy; therefore multicollinearity was unlikely to be problematic.

Wave 1 Inattention and hyperactivity: predictions of wave 2 alcohol expectancies

Four separate multiple regression equations, reflecting the positive-social, negative arousal, sedated/impaired, and wild/crazy factors of alcohol expectancies, were constructed to determine the independent and prospective association of the total number of Wave 1 inattention and hyperactivity symptoms with expectancies, controlling for the child's age, sex, IQ, and number of ODD/CD symptoms at Wave 1 (see Table 3). The total number of Wave 1 ADHD symptoms positively predicted more arousing (i.e., "wild/crazy") alcohol expectancies at Wave 2 [F (7, 131) = 2.58, $p = .02$; $R^2\Delta = .08$, $p = .004$]. Specifically, controlling for the same covariates, the number of Wave 1 hyperactivity symptoms significantly incremented predictions of future wild/crazy alcohol symptoms ($\beta = .38$; $p = .002$), whereas the number of inattention symptoms did not ($\beta = .00$; $p = .97$). Individual differences in the remaining alcohol expectancy domains were not significantly sensitive to the total number of Wave 1 ADHD symptoms or separate counts of inattention and hyperactivity symptoms beyond the Wave 1 covariates of age, sex, IQ, and ODD/CD symptoms: positive-social [F (7, 131) = 2.12, $p = .05$; $R^2\Delta = .01$, $p = .64$; inattention: $\beta = -.05$; $p = .62$, hyperactivity: $\beta = -.06$; $p = .60$]; negative arousal [F (7, 131) = 1.29, $p = .26$; $R^2\Delta = .02$, $p = .23$; inattention: $\beta = .11$; $p = .30$, hyperactivity: $\beta = .10$; $p = .42$]; and sedated/impaired [F (7, 131) = 1.37, $p = .22$; $R^2\Delta = .01$, $p = .64$; inattention: $\beta = .01$; $p = .94$, hyperactivity: $\beta = .10$; $p = .41$)] (Table 3).

Association of wave 2 ADHD symptoms with alcohol expectancies

Controlling for age, sex, and IQ, as well as Wave 2 ODD and CD, Wave 2 hyperactivity symptoms were significantly and positively associated with wild/crazy expectancies ($\beta = .31$; $p = .01$) whereas inattention symptoms were not ($\beta = -.14$; $p = .23$), consistent with the regression findings reported above. Wave 2 hyperactivity and inattention symptoms were not associated with the other three alcohol expectancy subscales.

Table 3. Summary of hierarchical regression analyses predicting alcohol expectancies.

Predictor	$R^2\Delta$[a]	β[b]	p[c]
MMBEQ Wild/crazy			
Step 1	.04		.33
Age at Wave 1		−.06	.48
Sex		.15	.09
IQ		−.07	.44
Number of ODD symptoms		−.02	.83
Number of CD symptoms		−.09	.34
Step 2	.08		<.01**
Number of Inattention symptoms		.00	.97
Number of Hyperactivity/Impulsivity symptoms		.38	<.01**
MMBEQ Positive-social			
Step 1	.10		.02*
Age at Wave 1		.24	<.01**
Sex		.16	.07
IQ		.07	.41
Number of ODD symptoms		−.12	.21
Number of CD symptoms		.04	.68
Step 2	.01		.64
Number of Inattention symptoms		−.05	.62
Number of Hyperactivity/impulsivity symptoms		−.06	.60
MMBEQ Negative arousal			
Step 1	.03		.48
Age at Wave 1		.05	.57
Sex		.01	.93
IQ		−.12	.18
Number of ODD symptoms		−.08	.42
Number of CD symptoms		.13	.16
Step 2	.03		.17
Number of Inattention symptoms		.10	.37
Number of Hyperactivity/impulsivity symptoms		.14	.25
MMBEQ Sedated/impaired			
Step 1	.06		.13
Age at Wave 1		.12	.15
Sex		.01	.88
IQ		−.09	.28
Number of ODD symptoms		−.17	.06
Number of CD symptoms		.19	.05*
Step 2	.01		.64
Number of Inattention symptoms		.01	.94
Number of Hyperactivity/impulsivity symptoms		.10	.41

Note. Hyperactivity/impulsivity symptoms = total symptoms endorsed for the attention deficit/hyperactivity disorder (ADHD) hyperactivity/impulsivity cluster on the Diagnostic Interview Schedule for Children—Fourth Edition (DISC-IV); Inattentive symptoms = total symptoms endorsed for the ADHD inattention cluster on the DISC-IV; ODD symptoms = total number of ODD symptoms from the DISC-IV; CD symptoms = total symptoms endorsed for conduct disorder on the DISC-IV; Sex coded: 1 Male, 2 Female; MMBEQ = Memory Model-Based Expectancy Questionnaire.

[a]Change in R2 associated with each predictor with control of all preceding variables.

[b]β is standardized and reflects association with outcome with simultaneous control of previous variables.

[c]Significance level associated with predictor.

*$p < .05$. **$p < .01$.

Discussion

Despite replicated evidence that ADHD predicts alcohol and substance use outcomes, the literature has several salient limitations: (a) Given that ADHD is frequently comorbid with ODD and CD, the predictive validity of ADHD for alcohol and substance outcomes may spuriously reflect co-occurring ODD/CD; (b) despite their covariation, inattention and hyperactivity are empirically distinct; thus, predictions from early ADHD must separately parse apart the potentially independent or unique association of inattention and hyperactivity with respect to key outcomes; and (c) although positive alcohol expectancies predict alcohol engagement overall, the association of ADHD with alcohol expectancies in children is unknown. Using an ethnically diverse sample of alcohol-naïve youths followed prospectively, the current study addressed these limitations directly. That is, we specifically ascertained whether early inattention and hyperactivity symptoms were independently associated with alcohol expectancies, controlling for age, sex, IQ, and ODD/CD symptoms. Wave 1 hyperactivity (age 6 to 9) uniquely and positively predicted Wave 2 (age 8 to 13) arousing alcohol expectancies (i.e., "wild/crazy") among alcohol-naïve youths. In contrast, Wave 1 inattention and hyperactivity were unrelated to Wave 2 negative alcohol expectancies (i.e., negative arousal, sedated/impaired) and positive social expectancies. Furthermore, we found that concurrent ADHD symptoms were consistent with the prospective findings: specifically, Wave 2 hyperactivity was positively associated with Wave 2 wild/crazy alcohol expectancies.

Interestingly, children with more hyperactive symptoms expected that alcohol would increase the frequency of "wild and crazy" behavior. Given that ADHD overall, and hyperactivity in particular, is strongly associated with poor social functioning (Erhardt & Hinshaw, 1994; Ronk, Hund, & Landau, 2011), this may contribute to the fact that in the current sample, ADHD symptoms were unrelated to the more traditionally socially positive expectancies associated with alcohol use (Brown et al., 1987; Chartier et al., 2010). This formulation is further substantiated by the correlational analyses in which ADHD symptoms were inversely associated with "positive-social" symptoms. In the only other study examining ADHD and alcohol expectancies, a cross-sectional study of college students found that ADHD symptoms and positive alcohol expectancies each positively predicted alcohol-related problems (Dattilo, Murphy, van Eck, & Flory, 2013). Given that hyperactivity was prospectively *and* concurrently associated with arousing alcohol expectancies in the current study (above and beyond multiple stringent covariates), and the well-established prediction of alcohol problems from positive alcohol expectancies (Chartier et al., 2010), we contend that arousing and positive alcohol expectancies represent a plausible intermediate construct between ADHD symptoms and later alcohol-related problems. In other words, the development of arousing and positive alcohol expectancies among children with ADHD may offer a cognitive mechanism by which these youths engage in early-onset alcohol use and experience alcohol-related problems. Although this was not formally evaluated in the present study, future studies, including continued follow-up of this sample into adolescence and assessment of alcohol engagement, should prioritize formal evaluation of the putative mediational role of alcohol expectancies in predictions of alcohol/substance use and related problems from early ADHD.

These preliminary findings are aligned with the acquired preparedness model for the development of alcohol expectancies, which posits that disinhibition promotes positive alcohol expectancies and subsequently influences greater drinking behaviors (Smith & Anderson, 2001). Our findings suggest that hyperactivity, as opposed to inattentive symptoms, appears to be a precursor to positive expectancies. Given that disinhibition is a core feature of ADHD (Barkley, 1997; Nigg, 2001; Nigg & Casey, 2005), these findings suggest that wild/crazy alcohol expectancies may partially mediate the association of disinhibitory behaviors associated with ADHD and alcohol use. In contrast, inattentive symptoms may be more directly related to substance use behaviors (Molina & Pelham, 2003), as opposed to the development of expectancies regarding substance use. Because hyperactivity symptoms uniquely (beyond IQ, inattention, ODD, and CD) predicted the development of arousing alcohol expectancies, future follow-up of these youths, particularly in regard to hyperactivity and impulsivity symptoms, will afford opportunities to test whether these dimensions predict actual alcohol engagement and/or alcohol-related problems.

Clinical relevance

Although illicit substance use is of great public health concern, the early initiation of substance use is particularly costly. Using propensity matching procedures, Odgers and colleagues (2008) found that children who initiated alcohol use before age 15 demonstrated worse outcomes (e.g., substance dependence, sexually transmitted diseases, early pregnancy, criminal activity) relative to later substance-initiating youths (i.e., after age 15). These findings provide persuasive, albeit non-experimental, evidence that early alcohol and substance engagement may be a potential causal risk factor for negative outcomes rather than simply reflecting or indicating a more extensive array of additional risk factors. Therefore, preventing *early* alcohol use is a potentially significant public health priority and understanding the putative contribution of children's arousing alcohol expectancies may facilitate interventions to prevent early alcohol initiation. For example, Cruz and Dunn (2003) found that intervention-induced changes in alcohol expectancies significantly reduced children's positive and arousing expectations about alcohol, as well as increased their association of alcohol with more negative effects. Therefore, interventions at this early stage in development may help delay alcohol use initiation and/or escalation, and thereby potentially prevent future alcohol problems. Preventive interventions based on risk factors may be more promising than traditional school-based substance use prevention strategies that have mostly consisted of negative information dissemination and resistance skills training (Pan & Haiyan, 2009; West & O'Neal, 2004). Altering "wild and crazy" as well as other positive expectancies more generally may have important implications, as previous research has shown that these expectancies are related to greater alcohol use (Gunn & Smith, 2010), as well as to earlier drinker status and problematic behaviors in fifth graders (Fischer et al., 2012). Implementing these interventions with significantly hyperactive youths may prevent initiation of early alcohol/substance use problems and/or make alcohol/substance problems more amenable to intervention.

Limitations

Several limitations should be considered when interpreting the current findings. Because alcohol expectancies were only collected at Wave 2, we were unable to predict change in alcohol expectancies (i.e., control for Wave 1 alcohol expectancies), a key consideration given that positive alcohol expectancies influence adolescent alcohol use and are affected by exposure to peer and parental behavior, as well as advertising (Brown et al., 1987). Therefore, not only is the pathway to alcohol and substance use from early ADHD likely to be mediated by multiple factors, so too may predictions of alcohol expectancies from ADHD. Future studies must implement differentiated measures of alcohol expectancies to delineate the specific role expectancies play in the development of problematic alcohol and substance use. While none of the parents in the sample met criteria for an alcohol use disorder, this study unfortunately had minimal data on parents' current drinking frequency and quantity, which is associated with children's expectancies (Molina, Pelham, & Lang, 1997). Twin studies have shown that environmental factors, such as parenting behavior, play an important role in the initiation of alcohol use; however, genetic factors appear to be a more important predictor of alcohol use than environmental factors, as well as alcohol-related problem behaviors in youths (Hopfer, Crowley, & Hewitt, 2003; Pagan et al., 2006). Future studies, examining genetic influences in both alcohol expectancy formation and ADHD may clarify underlying biological influences, including genetic factors that may be partially environmentally mediated. Finally, the term *positive alcohol expectancies* typically subsumes the MMBEQ subscales of "positive-social" and "wild/crazy" (i.e., arousing; Dunn & Goldman, 1996, 1998); however, there was no significant association between ADHD and positive-social expectancies. The wild/crazy subscale represents the arousing effects of alcohol use, and includes the adjectives loud, wild, goofy, crazy, and hyper, as well as the reverse-coded terms calm and quiet, all of which are words that can be positive or negative depending on the context. Although ADHD symptoms did not predict clearly positive (e.g., fun, cool, happy) or clearly negative (e.g., mean, rude, stupid) expectancies from the other MMBEQ subscales, they predicted these more ambiguous, potentially socially positive expectancies.

In sum, we found that the number of hyperactivity symptoms prospectively and concurrently predicted youth self-reported expectancies about the arousing properties of alcohol, above and beyond the effects of inattention and ODD/CD symptoms, which are known precursors of heavy alcohol use, as well as age, sex, and IQ. Future studies must rely on prospective longitudinal designs to examine the predictors and development of alcohol expectancies in youth, as well as their mediating/moderating processes. Given the clinical and public health significance of alcohol problems, particularly early in development, improving knowledge about precursors to alcohol use and problems in youth will lead to the identification of novel targets for intervention and prevention efforts.

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