

Psychology of Addictive Behaviors

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Online First Publication, April 9, 2020. <http://dx.doi.org/10.1037/adb0000582>

CITATION

Margherio, S. M., Brickner, M. A., Evans, S. W., Sarno Owens, J., DuPaul, G. J., & Allan, N. P. (2020, April 9). The Role of Emotion Regulation in Alcohol Use Among Adolescents With Attention-Deficit/Hyperactivity Disorder. *Psychology of Addictive Behaviors*. Advance online publication. <http://dx.doi.org/10.1037/adb0000582>

The Role of Emotion Regulation in Alcohol Use Among Adolescents With Attention-Deficit/Hyperactivity Disorder

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The purpose of the present study was to determine the role of emotion regulation in the pathway to problematic alcohol use among adolescents with attention-deficit/hyperactivity disorder (ADHD), specifically investigating the total effect of emotion regulation on problematic alcohol use and the indirect effect of emotion regulation through social skills on problematic alcohol use within a 2-wave longitudinal design. The potential protective effect of parent knowledge of these effects was assessed. Participants were 149 adolescents with ADHD (mean [M] = 15.11 years old; 78% male), and approximately 19% endorsed problematic alcohol use at Time 2. Contrary to our hypothesis, emotion regulation was not associated with subsequent problematic alcohol use without social skills in the model, and parent knowledge did not moderate this pathway. The results supported an indirect effect of emotion regulation on problematic alcohol use via social skills, although the direction of this effect was unexpected. Greater emotion regulation skills were associated with greater social skills, which in turn were associated with a higher likelihood of problematic alcohol use. Parent knowledge was protective against this indirect effect, such that the indirect effect was only present in the context of low parent knowledge. The findings delineate the roles of risk and protective factors associated with the progression from experimentation to alcohol use disorder among adolescents with ADHD.

Keywords: attention-deficit/hyperactivity disorder (ADHD), alcohol use, emotion regulation, social skills

Attention-deficit/hyperactivity disorder (ADHD) is a highly prevalent, chronic neurocognitive behavioral disorder affecting approximately 7% of youth (Thomas, Sanders, Doust, Beller, &

Glasziou, 2015). ADHD is associated with issues across several domains, including impaired social functioning, conflict with parents (Wehmeier, Schacht, & Barkley, 2010), and difficulties in emotion regulation (Bunford, Evans, & Wymbs, 2015). Although the pattern of ADHD symptoms may change as children develop, the symptoms and associated impairment often continue into adolescence (Wolraich et al., 2005). A particular concern among adolescents with ADHD is alcohol-related behaviors because these youth may initiate substance use at a younger age (Sibley et al., 2014) and endorse more frequent drunkenness and alcohol-related problems than their same-aged peers (Molina & Pelham, 2003). These differences in alcohol use patterns have been found to be particularly strong among older (e.g., 15–17 years) rather than younger adolescents (Molina, Pelham, Gnagy, Thompson, & Marshal, 2007). This pattern of risky alcohol use may continue to increase across the life span: Meta-analytic studies have found that childhood ADHD is predictive of the development of an alcohol use disorder in adulthood (Charach, Yeung, Climans, & Lillie, 2011; Lee, Humphreys, Flory, Liu, & Glass, 2011).

Despite findings linking ADHD to risky alcohol use in adolescence and alcohol use disorders in adulthood, ADHD has not been consistently linked to higher rates of alcohol use frequency (Lee et al., 2011; Molina et al., 2012; Sibley et al., 2014) or the presence

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The data presented in this article were obtained in a project supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R305A140356. The content is solely the responsibility of the authors and does not necessarily represent the official views of the Institute for Education Sciences. The authors declare that they have no conflict of interest. The aims and results presented in this article have not been disseminated previously. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committees and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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of an alcohol use disorder during adolescence (Biederman et al., 1997; Molina & Pelham, 2003). These disparate findings demonstrate that the progression from alcohol use experimentation in adolescence to diagnosable alcohol use disorders in adulthood represents a critical stage in which individuals with ADHD may begin to diverge from their peers. In this stage, some adolescents with ADHD may begin to engage in problematic alcohol use behaviors that catalyze the development of alcohol use disorders in adulthood. Thus, an understanding of the early contributors toward a problematic progression of alcohol use among adolescents with ADHD is needed to inform prevention efforts prior to the development of an alcohol use disorder. By considering multiple child and familial risk and protective factors, researchers may begin to clarify the pathways toward and away from problematic alcohol use among adolescents with ADHD. In the current study, we proposed and tested a model reflecting these complex pathways such that, among adolescents with ADHD, emotion regulation difficulties were associated with later problematic alcohol use via social impairment, and this indirect pathway was conditional upon parent knowledge (see Figure 1).

Emotion Regulation and Alcohol Use

Emotion regulation has been broadly defined as the ability to modify an emotional state in an adaptive, goal-oriented manner and involves processes of modulating reactions to stressful and emotional situations, as well as returning to baseline functioning afterward (Bunford, Evans, Becker, & Langberg, 2015). Among youth with ADHD, emotion regulation difficulties include difficulties modulating both negative and positive emotions, and therefore these youth may come across as more angry and frustrated or more exuberant than would be appropriate for the situation (Bunford et al., 2015). Current evidence suggests that difficulties with emotion regulation are particularly relevant for individuals with ADHD, with approximately twice as many adolescents with ADHD experiencing impairment in emotion regulation compared with community controls (Bunford, Evans, & Langberg, 2018). Further, a meta-analysis of 77 studies exploring emotion regulation and ADHD found a large effect size for the association between ADHD and emotion regulation ($d = .80$; Graziano & Garcia, 2016). Thus, adolescents with ADHD likely

experience difficulties monitoring and controlling shifts in emotion and expressing emotion in socially appropriate ways.

Several theories of alcohol use point to the role of emotional difficulties in contributing to alcohol use, including the stress and negative affect model (Colder & Chassin, 1993) and the stress-response dampening theory (Levenson, Sher, Grossman, Newman, & Newlin, 1980) of alcohol use. These models suggest that alcohol use may serve as a means of coping with or avoiding the experience of negative affect or as a means of amplifying pleasurable emotions. The role of emotion regulation in alcohol use may be particularly pronounced among individuals with ADHD because adults with ADHD are twice as likely as adults without ADHD to report using alcohol to enhance a positive mood and reduce a negative mood (Mitchell et al., 2018). Further, emotion lability, a manifestation of emotion regulation difficulties involving frequent and excessive displays of emotions, has been associated with an increased risk of substance use disorders among adolescents with ADHD (Sobanski et al., 2010). Taken together, emotion regulation difficulties appear to play a role in alcohol use and the progression toward substance use disorders among individuals with ADHD; however, no study to date has examined the role of emotion regulation in the development of problematic alcohol use among adolescents with ADHD. Given the potential malleability of emotion regulation (Mitchell et al., 2017; Suzer Gamli & Tahiroglu, 2018), a better understanding of the role of emotion regulation in the progression to alcohol use disorders may inform targeted prevention programs.

The Indirect Pathway via Social Skills

Emotion regulation may indirectly contribute to alcohol use via social impairment. Adolescents with ADHD who experience emotion regulation difficulties may be more likely to behave in socially inappropriate ways when experiencing strong emotions due to difficulties with self-soothing, refocusing attention, and inhibiting behaviors. They may also remain in intense emotional states for longer periods of time, be easily excitable, and be impatient (Bunford et al., 2015). These deficits in socially appropriate emotional reactions may contribute to impaired social skills and difficulties in interpersonal relationships. Indeed, empirical investigations have demonstrated that among youth with ADHD, difficulties with emotion regulation are associated with social impairment, including social skills deficits (Bunford et al., 2015) and poor peer liking ratings (Lee et al., 2018). Taken together, among youth with ADHD, emotion regulation is a critical factor in effective social functioning, potentially to a greater degree than ADHD symptoms alone.

These deficits in social skills may in turn amplify the risk for alcohol use in two main ways. First, youth experiencing difficulties with emotion regulation may have a limited arsenal of coping strategies, compounded with limited social skills, which may result in peer rejection and peer conflict. Thus, these youth may use substances as a coping strategy in reaction to social stressors and peer rejection. Second, through social influence and selection processes (e.g., Curran, Stice, & Chassin, 1997), adolescents with ADHD who experience social skill deficits may become involved with deviant peer groups as a result of rejection and isolation from the conventional peer groups, and this deviant peer group may create opportunities for engaging in alcohol use (Marshal, Molina,

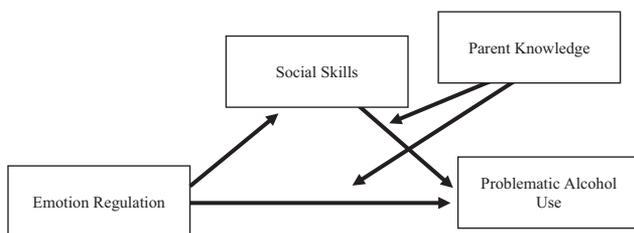


Figure 1. Conceptual model of the direct and indirect effects of emotion regulation on problematic alcohol use, conditional on parent knowledge. We hypothesized that worse emotion regulation skills would be associated with subsequent problematic alcohol use and that this pathway would be via social skills, such that poor emotion regulation would be associated with poor social skills, which would, in turn, be associated with problematic alcohol use. We hypothesized that high parent knowledge would be protective against the pathways to problematic alcohol use.

& Pelham, 2003). Indeed, longitudinal studies of youth with ADHD have supported the association between deficient social skills and later alcohol use (Hechtman & Weiss, 1986).

However, extant evidence also suggests that social skills deficits may serve a protective role in adolescents' substance use, such that among adolescents with ADHD, those experiencing social impairment may experience social isolation and, subsequently, less access to alcohol through peers. In two studies involving a longitudinal investigation of youth with ADHD, a protective pathway of social impairment was identified such that social impairment among individuals with childhood ADHD was associated with decreased heavy drinking in adolescence (Molina et al., 2012; Sibley et al., 2014). However, if the adolescent engaged with deviant peers, social impairment contributed to increased rates of alcohol use in adolescents with ADHD (Molina et al., 2012). These mixed findings regarding the role of social impairment in alcohol use among adolescents with ADHD suggest that social impairment could either amplify or diminish the risk for problematic alcohol use, and a third variable may buffer the risk of engaging in substances by influencing the adolescents' engagement with deviant peers.

The Interactive Effect of Parent Knowledge

Parents have the potential to provide a protective influence for their adolescents' perceptions of alcohol use and access to alcohol use through processes such as modeling, communicating their own expectancies of alcohol, enhancing the parent-child relationship, and monitoring the adolescents' friend groups and activities (Ryan, Jorm, & Lubman, 2010). Parent monitoring has been widely studied as a protective factor against adolescent risky behaviors. Parent monitoring includes multiple correlated components, including parent supervision, child disclosure, and parent knowledge (see Crouter & Head, 2002). Recently, researchers have distinguished between the differential roles of active parent efforts to monitor (i.e., soliciting information and tracking activities), parent supervision (i.e., parent presence during activities), and parent knowledge (i.e., parent awareness of youth's friends, whereabouts, and activities). Parent knowledge in particular may play a proximal role in protecting against risky behaviors because parent active efforts to monitor have been found to enhance parent knowledge, which in turn is associated with reduced adolescent antisocial behavior (Vieno, Nation, Pastore, & Santinello, 2009) and substance use (Lippold, Greenberg, Graham, & Feinberg, 2014; Vieno et al., 2009).

Parent practices may specifically dampen the association between risk factors and engaging in risky behaviors for adolescents with and without ADHD. For example, adolescent females with emotion regulation difficulties reported engaging in fewer risky behaviors (e.g., sexual behaviors) when parent supervision was high rather than low (Hadley, Houck, Barker, & Senocak, 2015). Additionally, parent knowledge of the child's activities and friend groups was found to dampen the associations between peer deviance and problematic alcohol use over time (Barnes, Hoffman, Welte, Farrell, & Dintcheff, 2006). Further, among adolescents with ADHD, Molina and colleagues (2012) found that social impairment was moderately and significantly associated with frequency of alcohol use when parent knowledge was low, but no such relationship existed when parent knowledge was high. Taken

together, parenting factors, particularly parent knowledge, have the potential to attenuate pathways between emotion regulation, social skills, and subsequent problematic alcohol use among adolescents with ADHD.

Current Study

Given the need to better understand the progression from alcohol use in adolescents to alcohol use disorders among individuals with ADHD, we investigated the pathway to problematic alcohol use among adolescents with ADHD. Using a longitudinal design, we investigated a pathway between emotion regulation and substance use, examining the pathway from emotion regulation to problematic alcohol use and the indirect effect of emotion regulation through social skills on problematic alcohol use. In addition, we evaluated a potential moderating effect for parent knowledge on these pathways (see Figure 1). In our analyses, we examined both engagement in any problematic alcohol use (i.e., a dichotomous outcome) and the degree of problematic alcohol use among those engaging in any problematic alcohol use (i.e., a continuous outcome). We explored several hypotheses within this model: (a) We hypothesized that worse emotion regulation skills would be associated with subsequent problematic alcohol use; (b) we hypothesized that the pathway between emotion regulation and problematic alcohol use would be conditional on parenting practices, such that high parent knowledge would dampen the pathway between emotion regulation and problematic alcohol use; (c) we predicted emotion regulation would be indirectly associated with problematic alcohol use via social skills, such that poor emotion regulation would be associated with poor social skills, which would, in turn, be associated with problematic alcohol use; and (d) we predicted the indirect effect of emotion regulation on problematic alcohol use would be conditional on parent knowledge, such that the pathway between emotion regulation and problematic alcohol use through social skills would be dampened with high parent knowledge.

Method

Participants

Participants in this study included 149 adolescents with ADHD (78% male). The average age of participants at Time 1 (T1) was 15.11 years old (standard deviation [*SD*] = .88), and participants were enrolled in Grades 8 through 10. Most participants identified as White (75%), 15% identified as Black, and the remaining 10% selected "other." Most participants identified as non-Hispanic (93%). The participants in our sample came from families with a wide range of incomes, with 34% coming from homes with a household income of less than \$50,000, 34% having household incomes between \$50,000 and \$100,000, and 23% having household incomes of over \$100,000; the remaining 9% chose not to respond. Approximately 33% of the parents had attained a bachelor's degree or higher. Approximately 38% of the sample reported taking medication for ADHD at T1.

Procedure

The participants in the current study participated in a two-site randomized controlled trial (RCT) examining an intervention

study for high school students with ADHD (Owens et al., 2018). All procedures were approved by the university research boards and school administrators. Participants were randomized to a community care condition or a school-based multicomponent training intervention (for more details, see Owens et al., 2018) designed to increase academic, social, and overall success in these students.

Participants were recruited from and attended high schools in both rural and urban areas in Ohio and Pennsylvania. Recruitment began in the spring of 2015 during the second semester of the 2014–2015 school year. Participants were recruited over 2 successive years in Ohio and over 3 successive years in Pennsylvania. Recruitment was conducted through three primary methods: direct study announcement letters to all families, direct referral from school staff, and fliers posted in each school. Criteria for inclusion in the study required that children (a) attended one of the 12 participating schools; (b) met diagnostic criteria for at least one subtype of ADHD based on the Parent Children's Interview for Psychiatric Syndromes (P-ChIPS; Weller, Weller, Fristad, Rooney, & Schecter, 2000) or parent and teacher ratings on the Disruptive Behavior Disorders Rating Scale (DBD; Pelham, Evans, Gnagy, & Greenslade, 1992); (c) an IQ of 75 or above on a two-subtest score using the Wechsler Abbreviated Scale of Intelligence–Second Edition (WASI-II; Wechsler & Hsiao-pin, 2011); (d) did not meet a cutoff score on the Substance Abuse Subtle Screening Inventory, Adolescent, Second Edition (SASSI-2; Miller & Lazowski, 2001) indicating a high probability of a substance use disorder; and (e) did not meet diagnostic criteria for bipolar disorder, psychosis, or obsessive–compulsive disorder. Diagnostic criteria for ADHD were established using parent report on the P-ChIPS or parent or teacher report of ADHD symptoms on the DBD. Five individuals were excluded from the study due to a high probability of a substance use disorder at T1 in order to understand the developmental progression toward problematic alcohol use. These individuals were similar to the current sample in terms of demographic variables (i.e., four were male, one was Hispanic, all were White).

The analyses were based on the 80% of the original sample ($N = 149$) who continued enrollment in the study and completed Time 2 (T2) assessments. The present sample did not differ from the original sample in assigned condition, sex, race, school attended, grade, family income, T1 emotion regulation, T1 social skills, T1 parent knowledge, or T1 problematic alcohol use. However, 11% of the participants who only completed baseline assessments identified as Hispanic, whereas 7% of the current sample identified as Hispanic, indicating Hispanic youth were more likely to have missing data and therefore to be excluded from the current sample, $\chi^2(1, N = 186) = 7.29, p = .01$. Subsequent analyses revealed that ethnicity was not associated with problematic alcohol use.

Measures

Participants and their parents completed assessments at T1 and at the end of the academic year (T2). The time between T1 and T2 assessments ranged from 8 to 15 months (mean [M] = 11.12, $SD = 1.67$), indicating variability in the opportunities for environmental influences on alcohol use across participants. All families were compensated \$100 for the eligibility assessment and \$50 for completing rating scale measures at T2. Rating scales were

completed online using the Research Electronic Data Capture (REDCap) system (Harris et al., 2009).

Emotion regulation. Emotion regulation was measured using the Emotion Regulation Index for Children and Adolescents (ERICA; MacDermott, Gullone, Allen, King, & Tonge, 2010) at T1. The self-reported ERICA measured adolescents' perceived sense of self-control, emotional self-awareness, and situational responsiveness. The ERICA contains 16 items in which adolescents rate the degree to which statements about emotion regulation skills describe them, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Items on the ERICA were summed to form the emotion regulation variable, with higher scores reflective of more adaptive or functional emotion regulation. The ERICA has demonstrated good internal consistency and good test–retest reliability (MacDermott et al., 2010). The internal consistency of the ERICA in the current sample was good (Cronbach's $\alpha = .81$).

Social skills. Social skills were measured by the parent-report Social Skills Improvement System (SSIS; Gresham & Elliott, 2008) at T1 and T2. The SSIS was designed to assist in the identification of students from ages 8 to 18 years who are suspected of having social skill deficits (Gresham & Elliott, 2008). The Social Skills domain was used in this study and is associated with aspects of communication, such as engagement, empathy, and cooperation. Parents rated the frequency of their adolescents' behaviors on 46 items with a Likert-style scale ranging from 0 (*never*) to 3 (*almost always*). Higher raw scores indicate greater use of socially skilled behaviors. Extensive support for the measure's validity, reliability, and internal consistency is available (Gresham, Elliott, Cook, Vance, & Kettler, 2010). The internal consistency of the Social Skills subscale in the current sample was excellent (Cronbach's $\alpha = .96$).

Parent knowledge. Parent knowledge was measured by the parent-report Alabama Parenting Questionnaire 9-item version (APQ-9) Poor Monitoring/Supervision subscale (Elgar, Waschbusch, Dadds, & Sigvaldason, 2007) at T1. This subscale measured the degree to which parents are aware of their adolescents' activities and friendships, and we therefore refer to this measure as *parent knowledge*. Items on the subscale include the following: "How often does your child fail to leave a note or tell you where he/she is going?"; "How often does your child stay out late past the time he/she is supposed to be home?"; and "How often does your child go out with friends you don't know?" The scale includes three items measured on a Likert-style scale ranging from 0 (*never*) to 5 (*always*), and responses are summed to create the parent knowledge variable, with higher scores indicating less parent knowledge. With adolescent samples, the APQ-9 Poor Monitoring/Supervision parent-report subscale has demonstrated good internal consistency and good convergent validity by correlating with parent reports of disruptive behavior symptoms (Elgar et al., 2007). The internal consistency of the subscale in this sample was acceptable (Cronbach's $\alpha = .73$).

Problematic alcohol use. Problematic alcohol use was measured using the SASSI-A2 adolescent self-report (Miller & Lazowski, 2001) at T1 and T2. The Face-Valid Alcohol (FVA) subscale was used to measure teens' experience with problematic alcohol use. The FVA scale consists of 12 face-valid, Likert-style scale items assessing the frequency of alcohol use–related symptoms and behaviors, including acknowledged alcohol use, motivation and consequences of usage, and loss of control. Participants

were asked to endorse the frequency of engaging in activities such as “Drank alcohol during the day,” “Had more to drink than you intended to,” and “Lost friends because of your drinking.” Responses range from 0 (*never*) to 3 (*repeatedly*), and responses were summed to create the problematic alcohol use variable, with higher scores being indicative of greater alcohol use and associated consequences. The SASSI has demonstrated good convergent and predictive ability, and the FVA specifically has demonstrated high internal consistency (Miller, Woodson, Howell, & Shields, 2009). The internal consistency of the FVA subscale in this sample was excellent (Cronbach’s $\alpha = .93$).

Covariates. In order to control for other putative influences on the outcomes in this study, baseline scores, sex, treatment condition, T1 age, medication status, and number of months between T1 and T2 were entered as covariates. Months between T1 and T2 was selected as a covariate to account for variations in the number of opportunities for unmeasured environmental influences on alcohol use. Additionally, given the documented importance of conduct disorder in alcohol use (see Lee et al., 2011; Sibley et al., 2014), we considered adding conduct disorder symptoms as a covariate. However, in our sample, conduct disorder symptoms were unrelated to problematic alcohol use ($r = .13$, $p = .13$); therefore, we chose not to include conduct disorder symptoms in the model.

Data Analytic Strategies

All data were analyzed using Mplus Version 8.1 (Muthén & Muthén, 1998–2019). Due to the nature of alcohol use data (i.e., several nonusers), a two-part model was estimated as recommended by Atkins, Baldwin, Zheng, Gallop, and Neighbors (2013). Within the two-part model, one part of the model captured the likelihood of endorsing any problematic alcohol use, and the other part captured the degree of problematic alcohol use, conditional on engaging in any problematic alcohol use. Maximum likelihood estimation with robust standard errors and Monte Carlo integration were used. Intraclass correlation coefficients revealed that approximately 2% of the variance in emotion regulation and social skills and 9% of the variance in problematic alcohol use was

due to the school attended. To account for variance due to the school attended, the `TYPE = CLUSTER` command was employed in Mplus, which uses a sandwich estimator to create standard errors of the model coefficients that are robust to variance by school attended.

To test our first hypothesis regarding the pathway between emotion regulation and problematic alcohol use (i.e., the *c* path), the total effect of T1 emotion regulation on subsequent problematic alcohol use was calculated without social skills in the model, controlling for covariates. We tested our second hypothesis regarding the interaction of emotion regulation and parent knowledge on subsequent problematic alcohol use by calculating the centered product of these terms and regressing problematic alcohol use onto the product term.

The third and fourth hypotheses were examined simultaneously within the same model (see Figure 2). We followed procedures recommended by Cole and Maxwell (2003) for testing indirect effects within two-wave longitudinal designs. To test our third hypothesis regarding the indirect effects of emotion regulation on problematic alcohol use through social skills, the product of the path between T1 emotion regulation and T2 social skills (i.e., the *a* path) and the path between T1 social skills and T2 problematic alcohol use (i.e., the *b* path) was calculated with parent knowledge, the interaction effect, and all covariates in the model. The Monte Carlo method for assessing indirect effects was used to establish 95% confidence intervals (CIs) around the indirect effect of emotion regulation on alcohol use, using 5,000 bootstrap simulations (Selig & Preacher, 2008).

The fourth hypothesis predicted parent knowledge would attenuate the indirect effects on problematic alcohol use. Specifically, the interaction of parent knowledge and social skills within the indirect effect of emotion regulation on problematic alcohol use was assessed. Conditional indirect effects were analyzed based on procedures recommended by Stride, Gardner, Catley, and Thomas (2015), and the indirect effect was probed at high and low levels of parent knowledge (i.e., 1 *SD* below and above the mean, respectively). The Johnson–Neyman technique was used to iden-

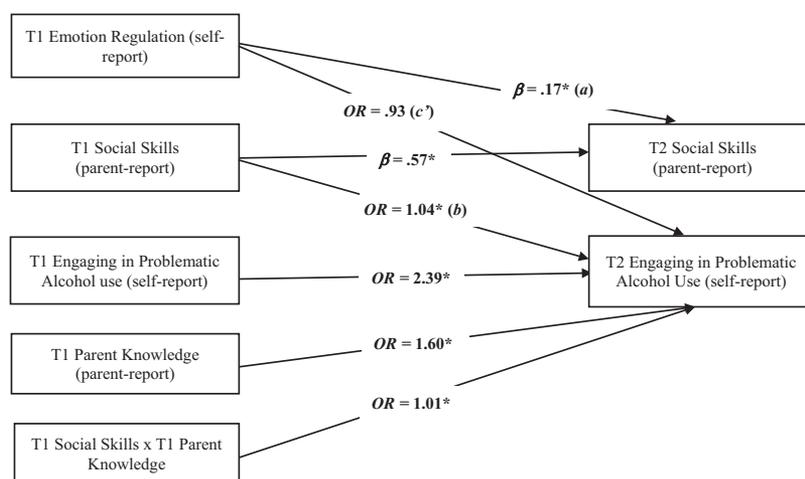


Figure 2. Results of the two-part model predicting engagement in problematic alcohol use. * $p < .05$.

tify ranges of parent knowledge for which the indirect effect was statistically significant (Preacher, Curran, & Bauer, 2006).

Results

Table 1 displays descriptive statistics of all variables included in the model. At T2, 19% of our sample endorsed any problematic alcohol use, with a mean problematic alcohol use score of .87 ($SD = 3.12$). The T1 emotion regulation variable was approximately normally distributed (skew = $-.15$, standard error [SE] = $.20$; kurtosis = $-.30$, $SE = .40$). Similarly, parent knowledge (skew = $.90$, $SE = .20$; kurtosis = $.54$, $SE = .40$) and social skills at both T1 (skew = $.14$, $SE = .20$; kurtosis = $-.30$, $SE = .40$) and T2 (skew = $.07$, $SE = .21$; kurtosis = $-.43$, $SE = .41$) were approximately normally distributed.

First, the total effect of emotion regulation on problematic alcohol use was examined without social skills in the model (see Table 2). The Bayesian information criteria (BIC) for the model was 330.82, and the Akaike information criteria (AIC) was 267.87. Due to the complex estimation required to estimate these models, traditional fit statistics and indices (e.g., model chi-square, root mean square error of approximation) are not provided when the outcomes are count variables. T1 problematic alcohol use was significantly positively associated with both engaging in problematic alcohol use at T2 (odds ratio [OR] = 2.21) and degree of problematic alcohol use among those engaging in problematic use ($\beta = .25$). A longer duration between assessments ($\beta = .37$) and having a prescription for stimulant medication ($\beta = .36$) were associated with greater problematic alcohol use at T2 among those engaging in any problematic use. Emotion regulation was not significantly associated with subsequent problematic alcohol use. Parent knowledge was significantly associated with engaging in problematic alcohol use ($OR = 1.32$), such that less parent knowledge was associated with greater odds of engaging in problematic use. The interaction between emotion regulation and parent knowledge on problematic alcohol use was not significant. Because this interaction was nonsignificant, it was dropped from the subsequent model.

Next, the indirect effect of emotion regulation on problematic alcohol use via social skills and the protective effect of parent knowledge on this pathway were examined using the two-part modeling approach. Model results are presented in Table 2, and Figure 2 depicts model results using engaging in problematic use as a binary outcome. The full-model BIC was 2,992.90, and the AIC was 2,896.98. T1 social skills were significantly positively associated with T2 social skills ($\beta = .56$). T1 problematic alcohol use was significantly and positively associated with engaging in later problematic alcohol use ($OR = 2.39$) and degree of use ($\beta = .21$). Among teens with ADHD who engaged in problematic alcohol use, being in the treatment condition ($\beta = .39$), being prescribed stimulant medication ($\beta = .29$), and a longer duration between assessments ($\beta = .40$) were associated with a greater degree of problematic alcohol use.

An indirect effect of emotion regulation on engaging in problematic alcohol use via social skills¹ was supported, although the directions of the relationships were unexpected. Better emotion regulation was positively associated with better social skills ($\beta = .17$), and better social skills were in turn associated with increased odds of engaging in problematic alcohol use ($OR = 1.04$). How-

ever, the Monte Carlo simulation revealed that the overall indirect effect was nonsignificant (95% CI [1.00, 1.03]). Because the effect of the interaction between social skills and parent knowledge on engaging in problematic alcohol use was significant ($OR = 1.01$), the indirect effect was probed at high and low levels of parent knowledge. This analysis revealed that the indirect effect was nonsignificant when parent knowledge was high (95% CI [.99, 1.02]) but significant when parent knowledge was low (95% CI [1.01, 1.04]). The Johnson–Neyman technique revealed that the indirect relationship between emotion regulation and engaging in problematic alcohol use via social skills was significant and positive when parent knowledge was .6 points above the mean, or a score above 6.03 in the present sample. Thus, because higher scores are indicative of low parent knowledge on the current measure, greater emotion regulation skills were associated with greater social skills, which in turn were associated with greater odds of engaging in problematic alcohol use only when parents reported low knowledge of their child's whereabouts, activities, and/or friends. The indirect effect was not supported for the degree of problematic use among those endorsing ever engaging in problematic use, although lower parent knowledge was associated with a greater degree of problematic use ($\beta = .71$).

Discussion

The current study investigated a model of putative, malleable risk and protective factors for problematic alcohol use among adolescents with ADHD. We specifically examined problematic alcohol use among mid- to late-adolescence individuals without prior history of substance use disorders in order to illuminate the potentially critical role of emotion regulation, social skills, and parenting practices within the progression from alcohol use to a substance use disorder. Notably, the current study utilized multiple-informant reports within a two-wave longitudinal design.

First, contrary to our hypothesis, we found that emotion regulation skills did not have a significant total effect on subsequent problematic alcohol use among adolescents with ADHD. Similarly, although parent knowledge was inversely associated with engaging in problematic use, there was no effect of the interaction between emotion regulation and parent knowledge on problematic alcohol use. However, our primary finding suggests that emotion regulation skills may be associated with problematic alcohol use via social skills, and parent knowledge may have a protective effect on this relationship. Greater emotion regulation skills were associated with better social skills, and these were associated with a greater likelihood of problematic alcohol use. Contrary to our prediction that problems in one area would be associated with problems in other areas, these findings suggest that better emotion regulation skills and, in turn, better social skills increase the chances that an adolescent with ADHD will engage in problematic alcohol use. Importantly, this indirect effect was conditional on parenting practices, such that this pathway was only present if

¹ An alternative reverse causal model was analyzed to enhance confidence that social skills contributed to problematic alcohol use rather than the converse. Problematic alcohol use was treated as a categorical mediator. The model yielded nonsignificant indirect effects, suggesting that emotion regulation does not contribute to social skills via problematic alcohol use.

Table 1
Descriptive Statistics of Participant Demographics and Variables in Analyses

Variable (range)	<i>M (SD)</i>	%
Sex		78% male
Race		75% White 15% Black
Ethnicity		93% non-Hispanic
Household income		34% <\$50,000 34% \$50,000–\$100,000 23% >\$100,000
Taking stimulant medication		38%
Age at BL (13–17)	15.11 (.88)	
Months from T1 to T2 (8–15)	11.12 (1.67)	
T1 emotion regulation (16–80)	58.43 (7.72)	
T1 social skills (0–138)	78.17 (17.42)	
T2 social skills (0–138)	85.38 (17.51)	
T1 parent knowledge (0–15)	5.43 (2.26)	
T1 problematic alcohol use (0–36)	.68 (2.14)	18% any problematic use
T2 problematic alcohol use (0–36)	.87 (3.12)	19% any problematic use

Note. BL = baseline; T1 = Time 1; T2 = Time 2.

parents reported below-average parent knowledge. Notably, this indirect pathway was not supported for the degree of problematic alcohol use among individuals engaging in problematic use. Our lack of findings regarding the degree of problematic use may have been the result of a relatively small portion of youth engaging in problematic alcohol use (19%). Emotion regulation and social skills therefore may play a role in minor problematic use, and their role in the progression to serious abuse and dependency difficulties requires further study.

Although the indirect effects of emotion regulation on alcohol use and the protective effect of parent knowledge were small in the

current study, it is important to consider that the outcome represented problematic alcohol use, including frequency of alcohol-related consequences, such as getting into trouble with the law, losing friends, or attempting to harm oneself, and therefore small differences in this outcome could be quite problematic in real-life situations. Additionally, these small effect sizes need to be considered in the context of the wide range of our emotion regulation and social skills measures (see Table 1). Given this wide range, even relatively minor changes in emotion regulation could contribute to an amplified likelihood of engagement in problematic alcohol use.

Table 2
Estimated Coefficients and 95% Confidence Intervals for Total, Direct, and Indirect Effects

	Social skills (SS)			Engaging in problematic alcohol use (AU)			Degree of problematic AU		
	<i>B</i>	95% CI	β	<i>B</i>	95% CI	<i>OR</i>	<i>B</i>	95% CI	β
Model 1: Total effect									
T1 problematic AU				.79*	[.49, 1.10]	2.21	.19*	[.08, .30]	.25
Tx condition				-.24	[-1.48, 1.01]	.79	.89	[-.22, 2.00]	.39
Sex				-.05	[-1.09, .99]	.95	.78	[-.12, 1.68]	.28
Months from T1 to T2				.07	[-.21, .35]	1.07	.25*	[.05, .45]	.37
Age				-.10	[-.79, .60]	.91	-.40	[-.94, .14]	-.30
Medication status				.30	[-.54, 1.13]	1.34	.84*	[.18, 1.49]	.36
T1 emotion regulation (ER)				-.04	[-.12, .03]	.96	.06	[-.05, .16]	.38
T1 parent knowledge (PK)				.28*	[.13, .43]	1.32	.33	[-.02, .67]	.65
T1 ER \times PK				.01	[-.01, .03]	1.01	.01	[-.04, .05]	.10
Model 2: Direct and indirect effects									
T1 problematic AU				.87*	[.50, 1.24]	2.39	.17*	[.05, .30]	.21
Tx condition	-3.72	[-9.28, 1.85]	-.11	.06	[-1.27, 1.39]	1.06	1.01*	[.06, 1.96]	.39
Sex	2.31	[-2.50, 7.12]	.06	-.07	[-1.35, 1.21]	.93	.72	[-.09, 1.53]	.23
Months from T1 to T2	-.23	[-1.15, .58]	-.03	.14	[-.17, .46]	1.15	.31*	[.13, .49]	.40
Age	-1.10	[-4.04, 1.84]	-.06	-.15	[-.87, .59]	.86	-.41	[-1.11, 1.30]	-.27
Medication status	-3.86	[-7.80, .07]	-.11	.28	[-.71, 1.27]	1.32	.78*	[.17, 1.40]	.29
T1 ER	.38*	[.13, .62]	.17	-.07	[-.15, .01]	.93	.06	[-.03, .15]	.35
T1 SS	.57*	[.47, .67]	.56	.04*	[.01, .07]	1.04	.02	[-.01, .04]	.23
T1 PK				.47*	[.23, .71]	1.60	.41*	[.04, .84]	.71
T1 SS \times PK				.01*	[.01, .02]	1.01	-.01	[-.02, .01]	-.23

Note. Tx = treatment; T1 = Time 1; T2 = Time 2.

* $p < .05$.

Our findings support previous evidence that emotion regulation skills are associated with social skills among individuals with ADHD (Bunford, Evans, Becker, et al., 2015; Bunford et al., 2018; Lee et al., 2018). In the context of ADHD, emotion regulation constitutes a youth's ability to modulate the speed, intensity, and duration of the physiological, experiential, and behavioral expression of an emotional reaction (Bunford, Evans, Becker, et al., 2015). Deficits across these areas may contribute to adolescent social skill deficits (Bunford, Evans, Becker, et al., 2015), and youth with limited social skills related to emotion regulation deficits may appear overly exuberant or irritable, annoying, rude, or disruptive, resulting in peer rejection (Lee et al., 2018) and social withdrawal.

In turn, our results suggest that these social skill deficits may be protective against engaging in problematic alcohol use when parent knowledge is low. Similar to our findings, evidence from other longitudinal studies suggests that social impairment can be protective against frequent alcohol use among individuals with ADHD (Molina et al., 2012; Sibley et al., 2014), potentially due to these individuals having less access to alcohol. Given that older adolescents are most likely to obtain alcohol from peers and unrelated adults as opposed to family members (King, Vidourek, & Merianos, 2016), better social skills related to greater abilities to modulate one's emotions increase the likelihood that adolescents will be in social situations in which alcohol is available, thereby increasing the risk of use. Further, it may be that problematic alcohol use is a social activity for adolescents, and this may require a degree of peer affiliation and social deviancy training that does not often exist for adolescents with emotion dysregulation and poor social skills. Specifically, Piehler and Dishion (2014) found that peers who have cooperative, smooth, and cohesive conversations and high levels of deviant talk were likely to increase substance use during adolescence and young adulthood. Adolescents with emotion dysregulation and poor social skills may be unable to have these types of relationships and coregulated conversations. More research is needed to examine the heterogeneous nature of social impairment among youth with ADHD and how specific facets of interpersonal effectiveness contribute to substance use in this population.

Our study contributes to the wealth of literature supporting the protective effect of parent knowledge on adolescent alcohol use. In our study, parent knowledge was defined as parent-reported knowledge of their adolescent's activities, friends, and location, and parent knowledge protected against the indirect pathway from emotion regulation to problematic alcohol use. This finding further suggests that the pathway from emotion regulation to problematic alcohol use via social skills may be due, in part, to access and social deviancy processes—it may be that adolescents whose parents are aware of their activities are less likely to be in social situations involving alcohol or less likely to give in to peer pressure regarding alcohol use. Rather, parents with greater knowledge of their child's activities may provide the necessary structure to enhance prosocial activities and decrease the influence of deviant peers among their socially skilled adolescents (Crouter & Head, 2002). Although we specifically measured parent knowledge in our study, other parenting practices, such as parent involvement and warmth, may further mitigate the risk for adolescent substance use (Lippold et al., 2014) and require further study.

It is important to note that our measure of parent knowledge may have been limited in its reliance on parent-report data. Indeed, researchers have reported that discrepancies between parent and adolescent reports are particularly useful when examining predictors of adolescents' alcohol use (Abar, Jackson, Colby, & Barnett, 2015), suggesting future researchers should consider the degree to which adolescents believe their parents are knowledgeable about their activities in addition to parent-perceived knowledge. Further, the current measure of parent knowledge contained items that may capture child disclosures and parent efforts to solicit information rather than specifically parent knowledge, and the relevance of these factors for adolescent substance use may depend on their impact on actual parent knowledge (Lippold et al., 2014). Therefore, more research is needed to unpack the specific parenting factors that are protective against problematic alcohol use among adolescents with ADHD.

The implications of our findings may raise difficult questions pertaining to treatment. Interventions for ADHD often target risk and protective factors for substance use difficulties, such as emotion regulation and social skills, yet no intervention to date has been effective in reducing substance use difficulties among this at-risk group (Molina & Pelham, 2014). Although emerging evidence suggests emotion regulation is a malleable treatment target (Mitchell et al., 2017; Suzer Gamli & Tahirglu, 2018), our findings suggest that improvements in emotion regulation could potentially have subsequent iatrogenic effects on problematic alcohol use in the context of low parent knowledge. Further, the current study is now one of three longitudinal studies demonstrating a positive link between social skills and substance use among adolescents with ADHD (i.e., Molina et al., 2012; Sibley et al., 2014), suggesting that treatments that improve social skills for this group may have negative downstream effects. However, treatments targeting social skills among youth with ADHD have been minimally effective (see Morris, Sheen, Ling, Foley, & Sciberras, 2020). As efforts continue to improve the effectiveness of social skills training and emotion regulation interventions for youth with ADHD, our findings suggest that these treatments should incorporate a parenting component to potentially buffer against possible iatrogenic effects. Additional moderator variables need to be investigated in order to enhance treatments that amplify the benefits of emotion regulation and social skill improvements while mitigating any potential unintended consequences. For example, although our current sample size precluded the investigation of additional moderators, factors such as community engagement and parent warmth may buffer against the subsequent risk for problematic alcohol use (see Molina & Pelham, 2014) and could therefore be targeted within interventions. Collectively, although it is certainly unwise to discourage treatments that improve emotion regulation and social skills, the fact that two large longitudinal studies have now found paradoxical relationships between social functioning and alcohol use among adolescents with ADHD should serve as a call to researchers and clinicians to be cognizant of efforts to maximize treatment effects while monitoring and addressing potential changes in alcohol use.

This study's findings should be considered within the context of its limitations. The current study used a two-wave longitudinal design, and therefore additional research is needed to examine these hypotheses within a three-wave design in order to strengthen claims of an indirect effect. Additionally, given the multiple path-

ways considered in this study, our analyses may have been underpowered to examine the full model, and more research is needed that utilizes larger samples. This study did not have a comparison group of typically developing adolescents, and thus it is currently unclear if the pathway from emotion regulation to problematic alcohol use via social skills is specific to adolescents with ADHD. Findings from the longitudinal studies of youth with ADHD have supported a protective role of social impairment in alcohol use in both individuals with and without ADHD (Molina et al., 2012); however, this path appeared to be stronger for individuals with childhood ADHD. Therefore, future studies should investigate whether the mediating role of social skills on the association between emotion regulation and alcohol use is unique to adolescents with ADHD. Although the use of multiple-informant indices increased confidence in our study's findings, our study may have been limited in its reliance on self-reported emotion regulation and parent-reported parent knowledge. Emotion regulation is likely best measured with multiple units of analysis, and therefore future studies should investigate the role of emotion regulation as measured by self- and parent report, physiological indices, and/or behavioral observations. Additionally, as mentioned previously, measuring parent knowledge by assessing the discrepancy between parent and child reports should be undertaken in future studies. Further, Hispanic youth were not well represented in our study, which may limit the study's generalizability to Hispanic youth with ADHD.

Despite the study's limitations, the current study offers several intriguing findings with important clinical implications. When examining problematic alcohol use longitudinally in a sample of adolescents with ADHD, we found that, in the context of low parent knowledge, emotion regulation skills contributed to greater social skills, which in turn contributed to problematic alcohol use. This was the second longitudinal study to identify such a paradoxical association between social skills and alcohol use among adolescents with ADHD. Collectively, these findings pose a potential dilemma in the design and implementation of interventions for adolescents with ADHD and suggest that attention to parenting practices for these adolescents may be a necessary intervention component. Researchers and clinicians alike need to consider how to best enhance adolescents' emotion regulation and social skills while avoiding increases in problematic alcohol use.

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Received October 24, 2019

Revision received March 15, 2020

Accepted March 17, 2020 ■