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Which Motivations Impact the Relation Between ADHD Symptoms and Simultaneous Use of Alcohol and Marijuana?

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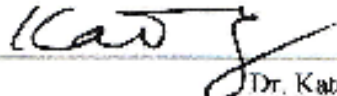
By

Caroline Hough

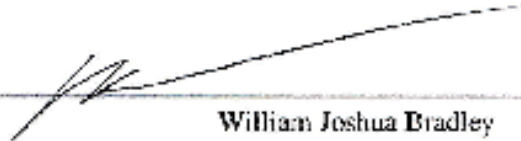
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Abstract

Attention-deficit/hyperactivity disorder (ADHD) symptoms are associated with greater risk for substance use and abuse. About one in four adults with ADHD has a comorbid substance use disorder. Polysubstance use, or mixing multiple drugs, is becoming increasingly prevalent on college campuses. The simultaneous use of alcohol and marijuana (SAM) is a particular polysubstance use pattern that is significantly correlated with more risky behaviors (e.g., reckless driving, unprotected sex) and adverse consequences (e.g., blackouts, physical injury) than using one substance alone. An estimated 15% of 18- to 29-year-olds engage in SAM each year, while recorded rates of SAM in college students are closer to 25%. As polysubstance use behaviors increase, it is important to understand how undergraduates with ADHD engage in SAM considering they are already at a higher risk of developing substance abuse disorders. Moreover, this investigation has clinical importance as the prevalence of college students with ADHD is rising with an estimated prevalence rate of 2-8%. The current study explores the relation between ADHD symptoms and SAM and the moderating role of motives for SAM in this relation. Data were drawn from the Undergraduate Learning, Emotion, and Attention Research Network (U-LEARN) study, an online survey-based study examining attention, learning, and psychological functioning in college students. Among students who reported using alcohol or marijuana in the past month, 22.6% (n=487) reported this use included engaging in SAM. Using binary logistic regression, the total number of ADHD symptoms reported was significantly associated with SAM. Despite this association, none of the four motive subscales examined (i.e., calm/coping, conformity, positive effects, or social) served as significant moderators in the relation. Inattentive symptoms were more strongly associated with SAM than hyperactive/impulsive symptoms. Implications of the results for future research and clinical practice will be discussed.

Keywords: ADHD, simultaneous use, polysubstance use, college

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Which Motivations Impact the Relation Between ADHD Symptoms and Simultaneous Use of Alcohol and Marijuana (SAM)?

Attention-deficit/hyperactivity disorder (ADHD) is a neurodevelopmental disorder characterized by two dimensions of symptoms: inattention (e.g., forgetfulness, distractibility, difficulty with sustained attention) and hyperactivity/impulsivity (e.g., interrupting others, inability to sit still), which significantly impair an individual's daily functioning (American Psychiatric Association, 2013). Diagnosis depends on the stability of six or more symptoms over a six-month period, and symptoms that occur across multiple contexts and manifest prior to 12 years of age.

Median age at ADHD diagnosis is 6 years old, while more severe cases are typically detected earlier, as young 4 or 5 years old (Visser et al., 2014). ADHD's nature as a developmental disorder means previous research centered heavily around childhood (Lovett et al., 2021; Young et al., 2010). However, there has been a shift in research over the past few decades to examine the disorder's impact across the lifespan (Resnick, 2005; Turgay et al., 2012). Longitudinal studies have revealed that ADHD persists into adulthood for about two-thirds of individuals (Karam et al., 2015; Sibley et al., 2021). This new perspective has resulted in a change in diagnostic criteria (Kieling et al., 2010). The DSM-IV necessitated the display of symptoms before age 7 for a diagnosis, but in the updated DSM-5, this cutoff changed to age 12 after being criticized for its poor utility (Todd et al., 2008). Possibly as a result of this expanded framework, or in response to other factors like increased awareness surrounding mental health (APA, 2019), the prevalence rate of ADHD in young adults and college students in particular has been on the rise over the past decade. In the Fall 2009 version of the National College Health Assessment, 5.1% of students reported having ADHD (American College Health Association,

2010), whereas 12.5% reported ADHD in the Fall 2021 survey (American College Health Association, 2022). Similarly, the 2009 estimates from Dupaul and Weyandt, ranging between 2 and 8% of college students with ADHD are in contrast with a large-scale epidemiological study in 2021 which estimated the undergraduate ADHD prevalence rate at 18.8% (Mak et al., 2021).

Individuals with ADHD are less likely to attend college than their counterparts (Hechtman et al., 2016). However, those who do attend face a unique set of challenges. Impaired academic functioning can manifest as organizational and time management difficulties, an inability to utilize study skills, and self-monitor, which can result in enrollment difficulties (e.g., dropping classes, completing fewer credit hours), lower GPAs and lower weekly performance on assignments, and lower graduation rates (DuPaul et al. 2018; Weyandt et al., 2013). Compared to their neurotypical peers, college students with ADHD also demonstrate increased social impairment, higher levels of anger, and difficulties with emotional functioning (e.g., mood fluctuations, flat affect) (Sacchetti et al., 2017; Weyandt et al., 2013). Moreover, undergraduates with ADHD have an increased propensity to engage in risky behaviors compared to their peers. This includes a higher likelihood of risky sexual behaviors (e.g., unprotected sex, more sexual partners, more pregnancies; Flory et al., 2006); substance use (Mochrie et al., 2018); reckless driving, and even gambling (Pollack et al., 2019). Perhaps consequently, undergraduates with ADHD self-report lower levels of self-esteem (Shaw-Zirt et al., 2005). A study by Pinho and colleagues also found that undergraduates with ADHD reported lower quality of life compared to their counterparts without comorbid disorders (Pinho et., 2019).

ADHD and Substance Use

A particularly strong concern for individuals with ADHD is the disorder's association with substance use and substance use disorders (SUDs). A meta-analysis of twenty-nine studies

by van Emmerik-van Oortmerssen and colleagues (2012) estimated that nearly one-fourth of substance use disorder (SUD) patients have comorbid ADHD. Beyond this correlational relation, ADHD predicts the development of SUDs. A longitudinal study by Wilens et al. (2011) that followed 497 children over a ten year transition into adulthood determined that individuals with ADHD were 1.47 times more likely to develop a SUD than their counterparts. Individuals who reported childhood ADHD are also more likely to experience early onset of a SUD (Lee et al., 2011). For example, in a sample of 1,276 adults currently in treatment for SUDs, 290 met the diagnosis for childhood ADHD (Kaye et al., 2019). Two hundred eleven of these patients experienced adulthood persistence of ADHD with notably severe presentations. Compared to those with remitted ADHD, this group reported early onset of illicit amphetamine use (perhaps for self-medication) as well as longer durations and more days of cocaine use. Interestingly, the groups reported nearly equal rates of past ADHD diagnosis and treatment. This suggests that the persistence of ADHD into adulthood and the development of comorbid SUDs may be dependent on factors other than treatment availability.

Etiologically, ADHD and SUD, both highly heritable disorders (ADHD= 80%, SUDs= 40-80%) (Slobodin & Crunelle, 2019) could share similar neural differences, such altered functioning in the dopaminergic pathway. Consequently, these disorders are both marked by impulsivity-related traits. “A lack of premeditation, lack of perseverance, sensation seeking, negative urgency, positive urgency, and reward sensitivity” are related to problematic alcohol use specifically (Stauz & Cooper, 2013, p. 594). Beyond having a genetic predisposition to one or both of these disorders, children who grow up in an environment of substance use may internalize these behaviors and later mimic them through social learning theory. In a sample of 1.1 million children, aged 6 to 19, the biggest predictor of childhood ADHD (measured through

the use of stimulant prescriptions) was a parent's substance abuse-related diagnosis (Lindblad et al., 2011). Another study associated childhood ADHD (with either comorbid conduct disorder or oppositional defiant disorder) with maternal stimulant and cocaine dependence and problematic drinking in fathers (Chronis et al., 2003).

Substance Use Behaviors of Undergraduates

Substance use is frequent among undergraduates. According to the 2019 National Survey on Drug Use and Health, over a one-month period, 21.1% of full-time college students aged 18 to 22 used marijuana, 52.5% used alcohol, and 33.0% reported binge alcohol use (Substance Abuse and Mental Health Services Administration, 2020). Over a yearlong period, 8.7% met the criteria for alcohol use disorder and 12.6% for general substance use disorder. For undergraduates, like their adult counterparts, ADHD is associated with higher rates of substance use and SUDs. For example, in a sample of 1,748 college students, those with ADHD were more likely to report frequent use of marijuana and alcohol (binge drinking) compared to their peers (Mochrie et al., 2018).

Current literature, however, presents conflicting findings about the role of comorbid disorders in the relation between ADHD and substance use in the undergraduate population. Several studies indicate that comorbid disorders do not alter this association. For example, independent of conduct disorder histories, ADHD was associated with more frequent tobacco use, high rates of dangerous alcohol use, marijuana use, and the use of illicit drugs in a sample of 91 undergraduate students (Rooney et al., 2012). But other studies do suggest that comorbidities, specifically conduct disorder, are significant predictors of substance use in college students with ADHD. Indeed, a survey of 889 undergraduates found that the relation between ADHD and alcohol or illicit drug use was no longer significant when controlling for comorbid conduct

disorder (Glass & Flory, 2012). However, the relation remained significant for alcohol-related problems and cigarette smoking. Similarly, Pollak and colleagues (2019) and colleagues linked ADHD to a wide variety of risky behaviors, including substance use, independent of comorbid psychiatric disorders in adults ($M^{\text{age}} = 24$) (2021). One study that reconciles these two perspectives found that ADHD alone was a significant predictor of SUD, but comorbid conduct or oppositional defiant disorder greatly strengthened this relation (Wilens et al., 2011).

Simultaneous Use of Alcohol and Marijuana (SAM)

Current explorations into the predictors and motivations surrounding substance use have transitioned from studying single substances to acknowledging that polysubstance use is frequent. Secondary analysis of the 2005 and 2010 waves of the National Alcohol Survey reveal that about 15% of 18- to 29-year-olds engaged in SAM annually (Subbarman & Kerr., 2015). Yet this rate may be higher on college campuses given that substance use is typically higher in undergraduate students compared to their non-enrolled peers. In fact, 22% of college freshmen reported moderate drinking with recent marijuana use, and 14% heavy drinking with recent marijuana use (Haas et al., 2015). In another sample of 1,389 undergraduates, 74% of those who reported using both alcohol and marijuana engaged in SAM in the past year (White et al., 2019). Within the college population, white males are the most likely to engage in SAM (Linden-Carmichael et al., 2019; Thompson et al., 2021). The advent of polysubstance-based research is especially important considering that the use of one substance may reinforce the use of another, creating a synergistic (potentiation) effect for the user, instead of simply having an additive effect (Lee et al., 2017). For example, young adults often describe the sensation of using alcohol and marijuana together as being “cross-faded.”

Individuals with ADHD and comorbid SUDs also exhibit patterns of polysubstance use. In a sample of 290 adults with both disorders, 83.1% were lifetime polysubstance users and over half had engaged in polysubstance use within the past month (Kaye et al. 2019). Moreover, in a longitudinal study, SAM predicted externalizing disorders including ADHD two years later (Thompson et al., 2021). They note that this relation is likely bidirectional, as externalizing problems can increase the risks of substance use, which in turn can cause greater impairment. SAM may be associated with riskier social environments and peer groups than single substance use, which can also exacerbate pre-existing issues.

There are two key frameworks for examining polysubstance use of marijuana and alcohol specifically. Concurrent use of alcohol and marijuana (CAM) refers to individuals who use both substances but not necessarily during the same occasion. Simultaneous use of alcohol and marijuana (SAM), which is examined in this study, refers to specific occasions of using both substances at the same time with interacting effects (Subbaraman & Kerr, 2015). A secondary analysis of two waves of the National Alcohol Survey revealed that young adults are twice as likely to engage in simultaneous use than concurrent use (Subbaraman & Kerr, 2015). This difference is notable because SAM is associated with more adverse effects than CAM or single substance use (White et al., 2019; Yurasek et al., 2017). Therefore, the current study uses SAM as a framework for examining co-use given its popularity and the associated risks.

Egan and colleagues' (2019) sample of over 2,500 15 to 25-year-olds revealed that SAM use in the party context was associated with a higher likelihood of experiencing a hangover, increased consumption of alcohol, increased disciplinary action by parents, and even correlated with risky sexual events, although rarer, such as having sex without a condom and experiencing sexual assault. Compared to those who only used alcohol, undergraduate SAM users were more

likely to experience DUIs, blackouts, physical injury, violence, cognitive consequences (e.g., reduced mental sharpness, and mental fatigue), drink more than they had intended, and drink with the motivation of getting drunk (Jackson et al., 2020; Haas et al., 2015; Lipperman-Creda et al., 2017). Longitudinal studies showed that first and second-year college students were more likely to record a higher number of drinks on days that they also consumed marijuana and this effect magnified over time, suggesting SAM may have increased through positive reinforcement (Gunn et al., 2018).

Motivations for Engaging in SAM

In 1948, Riley and colleagues identified motivation as “one of the most important theoretical and practical problems in the study of drinking behavior” (p. 353). Theoretical models of addiction imply a high degree of goal directedness (Sjoerds et al., 2014). Thus, motivations, or the reasons people use substances, directly predict both patterns of drug use (e.g., SAM) and related consequences. Recreational substance use has been linked to motives like curiosity and enhancing social interactions, while problematic substance use is associated with peer pressure and relieving physical or emotional pain (Haden & Edmundson, 1991). The four major facets of motivation in current research include calm/coping, conformity, social, and positive effects. These have been adapted in Pakula’s et al.’s SAM Measure (2009).

Current research into undergraduates’ susceptibility to SAM emphasizes the influence of social motivations. For example, White and colleagues (2019) found that undergraduates who participated in SAM perceived the influence of peer and friend norms as higher compared to those who did partake. Moreover, the social context of SAM can alter the likelihood of associated negative consequences. Increased adult supervision reduced SAM associated consequences by 54%, while if all users were at least 21 years old, risks were diminished by 99%

(Lipperman-Creda et al., 2017). Undergraduates were also more likely to participate in SAM at a friend's house or party, compared to bars or being at home. SAM was also positively correlated with being around more people.

For undergraduates with ADHD however, SAM, more than a social practice, may be a form of coping. In a ten-year longitudinal study, 36% percent of youth with ADHD reported using cigarettes or other substances (including alcohol and marijuana) to self-medicate. College students with ADHD are more likely to experience emotional dysregulation than their peers (Weyandt et al., 2018). Mochrie et al. (2020) demonstrated a correlation between marijuana use and comorbid depression in undergraduates. In a sample of college students with comorbid alcohol dependency, both positive and negative urgency mediated the relation between the two disorders. Positive urgency suggests the students were motivated by positive effects, while negative urgency can easily be applied to Pakula's calm and coping subscale.

The Current Study

Individuals with ADHD are more likely to engage in binge drinking, use marijuana, and are at a higher risk for developing substance abuse disorders (Zulauf et al., 2014; Lee et al., 2011). Therefore, it is critical to examine the link between ADHD and the simultaneous use of alcohol and marijuana (SAM), a particular use pattern associated with an increased risk for negative outcomes (Egan et al., 2019; Jackson et al., 2020; Haas et al., 2015; Lipperman-Creda et al., 2017). It is also important to examine which motives impact the relation between ADHD symptoms and SAM to better understand areas for potential intervention or prevention of SAM. Finally, understanding which symptom dimensions of ADHD (i.e., inattention vs. hyperactivity/impulsivity) are more related to SAM is an exploratory goal to help better understand the ADHD-SAM link. The current study therefore addresses the following aims:

Aim 1: Determine whether undergraduates' self-reported ADHD symptoms predict SAM.

Aim 2: Assess whether motivations for SAM (e.g., calm/coping, conformity, social, and positive effects) moderate the relation between ADHD symptoms and engagement in SAM.

Aim 3: Identify whether the strength of the association between ADHD symptoms and SAM differs according to ADHD symptom dimension (i.e., inattentive vs. hyperactive/impulsive dimension).

ADHD is associated with higher levels of both independently measured alcohol and independently measured marijuana use (Mochrie et al., 2018). Therefore, it can be hypothesized that undergraduates with ADHD are more likely to engage in SAM via their increased propensity for substance use. For undergraduates with ADHD, beyond the influence of social pressure, it can be hypothesized ADHD will be associated with calm and coping motivations, considering both independent marijuana and alcohol use have been linked to ADHD as a mechanism of self-medication (Daurio et al., 2008; Mochrie et al., 2021). Lastly, because SAM involves multiple forms of substance use, each linked to a different symptom dimension of ADHD, there are no specific predictions about the relation of ADHD symptom dimensions to SAM.

Methods

Participants

Data for this study was drawn from Wave 8 (2020-2021 academic year) of the Undergraduate Learning, Emotion, and Attention Research Network (U-LEARN) study. The sample consisted of 2,158 individuals who reported using either alcohol or marijuana (or both) in the past month. About one-fourth (26.2%, n=487) of these respondents reported past month SAM. This sample includes students from six different public universities located throughout various regions of the United States (Appalachian State University, University of Northern Iowa,

University of Wyoming, University of South Carolina, University of Colorado Boulder, University of Illinois Chicago, and Syracuse University). To participate in the study, individuals must have been enrolled undergraduate students, speak English, and be at least 18 years of age. Further inclusion criteria required passing 75% of attention checks placed throughout the survey (detailed below).

Participants were aged 18 to 26 ($M = 19.72$, $SD = 1.74$). For racial/ethnic identity, 72.0% of participants were White, 5.0% Black or African American, 8.7% Latinx or Hispanic, 6.3% Asian-American, 0.2% Native American/Indigenous, and 6.9% multiracial, 0.4% not listed, and 0.3% preferred not to answer. Biological sex breakdown of the sample was: 72.6% female and 27.2% male, while 0.2% preferred not to answer.

Procedure

The online survey, administered through a secure online survey platform, included a consent form; a demographics form; and a series of measures surrounding ADHD, substance use, and college adjustment. Four attention check questions (e.g., “A baby cat is called a _____”) were placed between measures to ensure participants were answering accurately across the survey, which was completed in about forty minutes to an hour. Participants were recruited through a combination of in-class announcements, flyers posted on campus, and the psychology departments’ study participant pools and department listservs. To compensate participants for their time, they were given the option to enter a raffle to win a \$100 Visa gift card (one per university) and most students also received research credit through their participant pool. All study procedures were approved by the university Institutional Review Board.

Measures

Demographic Information

Participants reported their age, biological sex, and race (Table 1).

ADHD Symptoms

The DSM-5 ADHD checklist (American Psychiatric Association, 2013) was used as a continuous measure of ADHD symptoms. Participants were asked to determine how well their non-medicated behavior over the past six months aligned with the 18 ADHD symptoms listed on this measure, using a Likert scale with four response options, ranging from Never or Rarely to Very Often. Two subscales can be extracted from the measure. The inattentive symptom dimension, consisting of 9 symptoms (e.g., being forgetful in daily activities, easily distracted by extraneous stimuli), has an internal consistency rating of 0.93. The hyperactive/impulsive symptom dimension, also consisting of nine items (e.g., talk excessively, acting as if driven by a motor) has an internal validity score of 0.88. A symptom was considered present if it was endorsed as “often or very often.” Total symptom counts were used as a continuous measure in this study. See Table 2 for ADHD symptom means.

Simultaneous Use of Alcohol and Marijuana

The Simultaneous Alcohol and Marijuana Use (SAM) measure (Pakula et al., 2009) is a single question that asks participants to recount how many days in the past month they used alcohol and marijuana together to combine both substances’ effects. (See Table 2 for SAM mean).

Motivations for SAM Use

The Simultaneous Alcohol and Marijuana Motives Questionnaire (Patrick, Fairlie, & Lee, 2018) is a 22-item checklist that uses a 5-point Likert scale ranging from 1= almost never/never to 5= almost always/always. Participants were asked to rate to what extent the listed reasons aligned with their motivations to engage in SAM. The measure has four subscales, which correspond to four possible motivations: calm/coping (e.g., to help me sleep, to help me calm

down), conformity (e.g., pressure from others, to fit in with a group I like), positive effects (e.g., to get a better high, to increase intoxication), and social (e.g., because it makes a social gathering more enjoyable, as a way to celebrate). An analysis of a 26-version of this measure showed that each subscale has internal validity between $\alpha = 0.77$ and $\alpha = .0.88$ (Patrick, Fairlie, & Lee, 2018). See Table 2 for means for the motives subscales.

Analytic Plan

Statistical analyses were conducted using version 27 of SPSS software. Missing data was removed using the listwise deletion setting. Descriptive statistics (Table 2) and bivariate correlations for all variables (Table 3) were computed. A binary logistic regression model was used to explore the relation between self-reported ADHD symptoms and whether or not a participant engaged in SAM use in the past month. Multiple regression models were used to explore whether SAM was associated with each motivation subscale (calm/coping, conformity, positive effects, and social) and ADHD symptoms (Model 1). For each motivation subscale an interaction variable was created (Aiken & West, 1991) and entered individually (hierarchical regression) and tested as a simple moderator in the relation between ADHD symptoms and occurrences of SAM (Model 2). Two simple regression models were conducted to examine whether one symptom dimension of ADHD predicted SAM behaviors significantly more than the other. In total, 7 models were analyzed.

Results

Assessing the Relation Between ADHD Symptoms and SAM

A binary logistic regression revealed that total ADHD symptoms were significantly associated with past month SAM ($\chi^2(1) = 37.326, p < .001$). This model correctly identified 77.4% of cases, but only explained 2.6% of the variation in SAM use (Nagelkerke R-Square). The odds ratio was 1.07, suggesting a minimal increase in SAM occurrences for each additional

ADHD symptom reported. 487 individuals who reported SAM use and completed measures on their motivations for doing so, 35.5% of them reported having been previously diagnosed with ADHD, while for the total sample of 2,158, 25.3% of individuals reported a past ADHD diagnosis.

Assessing the Moderating Role of Motivations Between ADHD Symptoms and SAM

Calm/Coping Motivations

Both model 1 and model 2 were significant for calm/coping motivations. However, model 2 ($r^2 = .080$) did not account for significantly more variance than model 1 ($r^2 = .082$). Results indicated that SAM was significantly associated with calm and coping motivations, but not ADHD symptoms. Thus, entered as an interaction variable alongside ADHD symptoms, calm/coping motivations were not a significant moderator in the relation between ADHD symptoms and SAM, ($\beta = .127$, $SE = .011$, $p = .323$). See Table 4.

Conformity Motivations

Both model 1 and model 2 were insignificant for conformity motivations. SAM was not significantly associated with ADHD symptoms, but not conformity motivations. Therefore, the interaction variable was not statistically insignificant in model 2 ($\beta = .079$, $SE = .006$, $p = .491$). See Table 5.

Positive Effects Motivations

SAM was significantly associated with positive motivations, but not ADHD symptoms. Positive motivations failed to serve as a moderator in model 2 ($\beta = .308$, $SE = .006$, $p < .016$). See Table 6.

Social Motivations

A moderation analysis revealed that social motivations did not moderate the relation between ADHD symptoms and SAM, indicating that this relation remained consistent regardless of social motivation for SAM ($\beta = -.020$, $SE = .007$, $p = .189$). See Table 7.

Evaluation of Moderation Effects According to ADHD Symptom Dimensions

A simple logistic regression was conducted to determine the effect that endorsing hyperactivity/impulsivity symptoms would have on the likelihood of engaging in SAM. The logistic regression model was statistically significant, $\chi^2(1) = 20.69$, $p < .001$. The model explained 1.4% (Nagelkerke R^2) of the variance in SAM and correctly classified 77.4% of cases. The resulting odds ratio was 1.114. Inattentive symptoms were also associated with SAM, yielding another statistically significant model, $\chi^2(1) = 40.40$, $p < .001$, that explained 2.8% of variance in SAM and correctly classified 77.4% of cases. This slightly higher predictive value is evident in a 1.12 odds ratio.

Discussion

Our hypothesis that ADHD symptoms would significantly predict SAM was supported; however, the association had a small effect size. This may be due to the fact that our sample was overwhelmingly female but that males are more likely to engage in SAM and be diagnosed with ADHD compared to females (Linden-Carmichael et al., 2019; Thompson et al., 2021; Mowlem et al., 2019). It is also possible that ADHD may better predict negative outcomes associated with SAM (e.g., impaired driving, risky sexual behavior), rather than SAM itself, which may be fairly normative for college students. In support of our findings, students with ADHD symptoms may less successfully mitigate the risks associated with SAM because of their comparative deficits in executive functioning. Similarly, SAM use for students with ADHD symptoms may also

exacerbate pre-existing difficulties in academic, social, or emotional functioning. For example, because students with ADHD already have increased academic difficulties compared to their counterparts (DuPaul et al. 2018; Weyandt et al., 2013), SAM may be more disruptive to their academic performance compared with their non-ADHD peers. Notably in our sample, SAM users had a mean GPA of 3.36 ($SD = .51$), compared to those who did not report SAM ($M^{GPA} = 3.45$, $SD = 2.4$).

The small effect size in the relation between ADHD and SAM may also be caused by marijuana's changing legality, which contributes to changes in usage patterns. Three universities represented in our sample are located in states where cannabis is fully legalized, decriminalized, and available medicinally. Two universities were in states where all types of cannabis use are illegal, and one university was located in a state where cannabis is decriminalized, but not legal or available medicinally. Subbarman's 2016 meta-analysis concludes individuals are more likely to completely replace drinking with cannabis use in places where penalties for marijuana use have been reduced or eliminated, perhaps because of reliable and safe access. While, in stricter environments, the two substances are more frequently used as complements.

Lastly, ADHD alone may not be an accurate predictor of SAM. The effect size of this relation may increase when comorbid disorders, such as conduct disorder or depression, are also considered. The role of comorbid disorders is still in the relation between ADHD and SUDs. While some studies show that ADHD is independently associated with SUDs, (Rooney et al., 2012); others show that this relationship only exists when there is comorbid conduct disorder present (Glass & Flory, 2012; Pollak et al., 2019). There is also little research on whether conduct disorder is independently associated with SAM or polysubstance use patterns. Davis and colleagues found that cannabis users that reported using marijuana simultaneously with tobacco

or simultaneously with alcohol, tobacco, and other illicit drugs endorsed a significantly higher amount of childhood CD symptoms (Davis et al., 2019). It is clear however that CD is associated with independent alcohol and marijuana use (Brown et al., 1996; Diamond et al., 2006; Molina et al., 2002).

SAM was associated with the calm/coping, positive effects, and social subscales. However, the conformity subscale was not associated with SAM. Conformity motives showed the worst fit among the subscales. Social pressures significantly contribute to SAM in neurotypical undergraduates. However, alleviating internal emotional discomfort caused by ADHD (and comorbid disorders) may be more important to undergraduates with ADHD than external social cues. For the three associated subscales, none of them remained significant when entered into model 2 as a variable interacting with ADHD symptoms. Thus, none of the motivations significantly moderated the relation between ADHD symptoms and SAM use. This suggests that the SAM motivations measure, although successful in predicting SAM behaviors for a regular undergraduate sample, has less utility when understanding the motivations of students exhibiting ADHD symptoms, considering ADHD and SAM were found to be significantly associated, albeit with a small effect size.

Additional motivations explored in the single substance context could be applied to the exploration of SAM motives for individuals with ADHD. For college-aged individuals, motivations and correlates for marijuana also include boredom (Goldstein et al., 2021), apathy (Petrucci et al., 2020), and low self-compassion (Wisener & Khoury, 2020). Boredom shows particular promise because of its relation to ADHD (Merrifield & Danckert., 2014). In a study of teenagers with ADHD, inducing boredom increased their risky decision making (Matthies et al.,

2012). Over the past few years, it is worthwhile to note that boredom was frequently reported by undergraduates during the covid-19 pandemic (Camacho-Zuñiga et al., 2021).

While both ADHD symptom dimensions showed modest associations with SAM, the inattentive subscale explained 50% more variance in the relation between ADHD symptoms and SAM than the hyperactive-impulsive subscale. Despite impulsivity's association with risky behaviors, the inattentive subtype has been previously linked with cigarette smoking (marijuana is also smoked and sometimes consumed with tobacco in it) (Lee et al., 2011). Moreover, this finding is similar to Bradley's conclusion that negative consequences of alcohol and marijuana use are also more strongly related to inattentive ADHD symptoms via experiential avoidance than impulsive symptoms (2022, under review).

Limitations

This study uses self-report data, which is subject to social desirability bias. Moreover, the sample was disproportionately women, although ADHD, SUDs, and SAM are more common in males (Lipperman-Creda et al., 2017; Mowlem et al., 2019). Additionally, since recruitment centered around the psychology participant pools and department listservs, psychology majors were overly represented. The biggest limitation in the analysis of survey data was the large proportion of incomplete forms, which had to be eliminated from analysis. It is possible that ADHD may have been highly prevalent among those who did not finish the entire survey, which lasted up to an hour, thus requiring sustained attention. Moreover, those with ADHD symptoms may have had a harder time understanding their motives for SAM, considering completing the motives measure requires introspection, a process which shows altered neural functioning in those with ADHD (Vadalà et al., 2011).

Future studies measuring the strength of the relation between ADHD and SAM in other undergraduate samples would be useful to compare to the present findings. Our large sample size

relied on the self-reporting of ADHD symptoms as a predictor of SAM rather than a clinician's diagnosis. Future studies may benefit by exploring the ADHD and SAM relation in a smaller sample, utilizing a more intensive diagnostic process. If the association is supported in other studies, understanding the motivations for students with ADHD to participate in SAM would be a critical step in developing interventions to reduce the adverse consequences associated with the practice.

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Table 1*Demographics*

Variable	<i>N</i> =	%
	2,158	
Biological Sex		
Male	587	27.2
Female	1586	72.6
Intersex	1	0
Prefer not to answer	4	.2
Race		
Asian	135	6.3
Black/African American	107	5.0
Latinx/Hispanic (Non-white)	188	8.7
Middle Eastern/North African	4	0.2
Native American/American Indian/ Alaska Native/Indigenous	4	0.2
Pacific Islander/Native Hawaiian	3	0.1
White	1554	72.0
Multiracial	149	6.9
Not Listed	8	0.4
Prefer not to answer	6	0.3

Table 2*Descriptives (SAM Users, n=487)*

	<i>M</i>	<i>SD</i>	Min-Max
ADHD Symptoms			
Inattentive	3.09	2.97	0-9
Hyperactive/Impulsive	1.90	2.17	0-9
Total	4.99	4.69	0-18
Motivations			
Calm/Coping	6.29	3.44	3-15
Conformity	11.41	5.01	8-40
Positive Effects	11.41	5.01	6-30
Social	10.88	4.89	5-25
SAM	2.23	3.47	0-31

Note. ADHD= Attention-Deficit/Hyperactivity Disorder, SAM= Simultaneous Alcohol and Marijuana Use

Table 3.

Correlations among variables of interest.

Variables	1	2	3	4	5	6	7	8	9
1. Calm/Coping Motivations	-								
2. Social Motivations	0.48**	-							
3. Conformity Motivations	0.32**	0.54**	-						
4. Positive Motivations	0.45**	0.63**	0.33**	-					
5. SAM-Yes	0.40**	0.39**	0.23**	0.47**	-				
6. Inattentive Symptoms	0.25**	0.15**	0.07	0.19**	0.14**	-			
7. H/I Symptoms	0.20**	0.10*	0.13**	0.10*	0.10**	0.54**	-		
8. Total ADHD Symptoms	0.25**	0.14**	0.10**	0.17**	0.13**	0.19**	0.01	-	
9. SAM-Number of Days	0.27**	0.18**	-.003	0.31**	0.48**	0.15**	0.11**	0.15**	-

Note. SAM= Simultaneous Alcohol and Marijuana Use, H/I= hyperactive/impulsive, ADHD= Attention-Deficit/Hyperactivity Disorder

Table 4.

*Summary of Hierarchical Regression Analysis Predicting SAM
Calm and Coping Subscale*

Variable	Model 1			Model 2		
	β	<i>SE</i> β	<i>p</i>	β	<i>SE</i> β	<i>p</i>
ADHD Symptoms	.081	.036	.063	-0.12	.086	.091
SAM Calm Subscale	.251	.050	<.001	.200	.076	.004
ADHD Symptoms x SAM Calm Subscale				0.127	.011	.323
<i>R</i>²	.080			.082		

Note. Variables with *p*-values < 0.01 denoted with bold font. ADHD= Attention-Deficit/Hyperactivity Disorder, SAM= Simultaneous Alcohol and Marijuana Use

Table 5.

*Summary of Hierarchical Regression Analysis Predicting SAM
Conformity Subscale*

Variable	Model 1			Model 2		
	β	<i>SE</i> β	<i>p</i>	β	<i>SE</i> β	<i>p</i>
ADHD Symptoms	.114	.037	.001	.082	.082	.420
SAM Conformity Subscale	-0.15	.033	.746	-.047	.047	.471
ADHD Symptoms x SAM Conformity Subscale				.079	.006	.491
<i>R</i>²			.021			.022

Note. Variables with *p*-values < 0.01 denoted with bold font. ADHD= Attention-Deficit/Hyperactivity Disorder, SAM= Simultaneous Alcohol and Marijuana Use

Table 6.

*Summary of Hierarchical Regression Analysis Predicting SAM
Positive Effects Subscale*

Variable	Model 1			Model 2		
	β	<i>SE</i> β	<i>p</i>	β	<i>SE</i> β	<i>p</i>
ADHD Symptoms	.104	.035	.016	-.147	.091	.193
SAM Positive Subscale	.298	.025	<.001	.184	.037	.004
ADHD Symptoms x SAM Positive Subscale				.308	.006	.016
<i>R</i>²	.108			.119		

Note. Variables with *p*-values < 0.01 denoted with bold font. ADHD= Attention-Deficit/Hyperactivity Disorder, SAM= Simultaneous Alcohol and Marijuana Us

Table 7.

Summary of Hierarchical Regression Analysis Predicting SAM Social Subscale

Variable	Model 1			Model 2		
	β	<i>SE</i> β	<i>p</i>	β	<i>SE</i> β	<i>p</i>
ADHD Symptoms	.125	.036	.005	-0.20	.096	.869
SAM Social Subscale	.170	.037	<.001	.106	.054	.108
ADHD Symptoms x SAM Social Subscale				.174	.007	.189
<i>R</i>²	.049			.052		

Note. Variables with *p*-values < 0.01 denoted with bold font. ADHD= Attention-Deficit/Hyperactivity Disorder, SAM= Simultaneous Alcohol and Marijuana Use