Consequences of Alcohol and Marijuana Use Among College Students: Prevalence Rates and Attributions to Substance-Specific Versus Simultaneous Use

Kristina M. Jackson, Alexander W. Sokolovsky,
and Rachel L. Gunn
Brown University

Helene R. White
Rutgers, The State University of New Jersey

College students who use alcohol and marijuana often use them simultaneously, so that their effects overlap. The present study examined whether negative consequences experienced by simultaneous alcohol and marijuana (SAM) users vary from those experienced by individuals who use alcohol and marijuana concurrently but not simultaneously (CAM) or single-substance users. We considered 9 types of consequences: cognitive, blackout, vomiting, academic/occupational, social, self-care, physical dependence, risky behaviors, and driving under the influence (DUI). Further, we examined whether consequences experienced by SAM users are attributed to using alcohol, marijuana, or both simultaneously. The sample included past-year alcohol and marijuana users age 18–24 ($N = 1,390$; 62% female; 69% White; 12% Hispanic) recruited from 3 U.S. college campuses. SAM users experienced a greater overall number of consequences than CAM or alcohol-only users, even controlling for frequency and intensity of alcohol and marijuana use and potentially confounding psychosocial and sociodemographic factors. Experiencing specific consequences differed between simultaneous and concurrent users, but after adjusting for consumption and other covariates, only blackouts differed. In contrast, SAM users were more likely to experience each consequence than alcohol-only users, with strongest effects for DUI, blackouts, and cognitive consequences. Among SAM users, consequences were most likely to be attributed to alcohol and were rarely attributed to simultaneous use. Being a user of both alcohol and marijuana and using alcohol and marijuana together so that their effects overlap each contribute to risk, suggesting there is value in targeting the mechanisms underlying type of user as well as those underlying type of use.

Keywords: alcohol, marijuana, simultaneous, consequences, college

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Most users of alcohol and marijuana use them simultaneously (i.e., so that their effects overlap; Agrawal et al., 2009; Brière, Fallu, Descheneaux, & Janosz, 2011; Collins, Ellickson, & Bell, 1998; Pape, Rossow, & Storvoll, 2009; Subbaraman & Kerr, 2015). Studies using national samples of adolescents and young adults show high rates of simultaneous alcohol and marijuana (SAM) use. Among 12th graders, 70% of past-year marijuana users also reported past-year SAM use, and 18% reported SAM use most times or every time they used marijuana (Terry-McElrath, O'Malley, & Johnston, 2013). Of alcohol users from 19–22 years old, 30% reported past-year SAM use (Terry-McElrath, Patrick, O'Malley, & Johnston, 2018), and over half (59%) of 4-year college students who drank in the past year reported being "cross-faded," a subjective term associated with being drunk and high at the same time (Patrick & Lee, 2018). These high prevalence rates for SAM use are concerning given

evidence that individuals who engage in SAM use are heavier and more frequent users of alcohol and marijuana than those who use alcohol alone (Brière et al., 2011; Collins et al., 1998; Egan et al., 2019; Midanik, Tam, & Weisner, 2007; Pape et al., 2009; Patrick & Lee, 2018; Patrick, Veliz, & Terry-McElrath, 2017; Terry-McElrath et al., 2013; Yurasek, Aston, & Metrik, 2017). This places them at greater risk for developing substance use disorders (Agrawal et al., 2009; Martin, Kaczynski, Maisto, & Tarter, 1996; Midanik et al., 2007) and experiencing negative consequences (Yurasek et al., 2017).

SAM Use and Adverse Outcomes

To date, the strongest empirical support for increased risk of experiencing adverse outcomes when using alcohol and marijuana simultaneously, compared to either substance alone, is in unsafe driving. SAM users demonstrate higher rates of driving under the influence, receiving tickets/warnings, and having alcohol-related accidents or fatalities (Arterberry, Treloar, & McCarthy, 2017; Chihuri, Li, & Chen, 2017; Harrington et al., 2012; Li, Chihuri, & Brady, 2017; Lipperman-Kreda, Gruenewald, Grube, & Bersamin, 2017; Ramaekers, Berghaus, van Laar, & Drummer, 2004; Subbaraman & Kerr, 2015; Terry-McElrath, O'Malley, & Johnston, 2014). SAM users are also more likely to engage in unsafe driving compared to those who use both alcohol and marijuana but not together (concurrent alcohol and marijuana, or CAM, users; Subbaraman & Kerr, 2015; Terry-McElrath et al., 2014). This suggests that SAM use confers additional risk compared to CAM use as well as compared to single-substance use.

SAM use also contributes to greater social consequences, mental health problems, and dependence symptoms relative to single-substance use (Yurasek et al., 2017). Among college students, diary-level reports of consuming alcohol and marijuana on the same occasion indicated more overall consequences relative to alcohol or marijuana alone with respect to impaired control, self-care, physical consequences, and social consequences, with effects most pronounced when marijuana was combined with alcohol at high levels (5+/4+ drinks per occasion for men/women; Mallett et al., 2017; Mallett, Turrisi, Trager, Sell, & Linden-Carmichael, 2019). Youth ages 15–20 who consumed both alcohol and marijuana at a party were more likely to be punished by their parent/guardian at or after the party than those who consumed alcohol alone (Egan et al., 2019). Further, adult SAM users report higher odds of social consequences (legal/accidents, health, relationship problems) and harm to self (feeling that drinking was harmful to friendships, social life, and financial position; Subbaraman & Kerr, 2015). The differential consequences experienced by SAM users are observed even controlling for sociodemographic variables and consumption when compared to alcohol-only users, although not relative to CAM users. This divergence in findings in comparisons of SAM versus alcohol-only and SAM versus CAM highlights the importance of carefully considering the reference group when examining consequences related to SAM use.

Additionally, laboratory studies have shown cognitive impairment effects of SAM use compared to either substance alone on several behavioral measures (Hartman, Brown, Milavetz, Spurgin, Pierce, et al., 2015; Ramaekers, Robbe, & O'Hanlon, 2000; Robbe, 1998; Ronen et al., 2010). Other than increased risk of blackouts for using alcohol and marijuana use on the same occasion (Mallett

et al., 2017) and effects of marijuana on memory (Caulkins et al., 2015), cognitive effects have not been clearly established outside of acute effects in the laboratory. When combined with alcohol's potential side effect of blackouts (Wetherill & Fromme, 2016), marijuana use may result in greater levels of cognitive impairment, putting individuals at increased risk for making more impulsive decisions. For example, studies using timeline follow-back (Hayaki, Anderson, & Stein, 2018; Metrik, Caswell, Magill, Monti, & Kahler, 2016), event-based (Egan et al., 2019), and daily diary (Parks, Collins, & Derrick, 2012) designs show that using both alcohol and marijuana on the same day synergistically increases the likelihood of unprotected sex on that day among young adults. Importantly, a study by Metrik and colleagues (2016) found this was true for heavy (5+/4+ drinks per occasion) but not moderate drinking.

Furthermore, simultaneous use can indirectly affect negative consequences. For example, marijuana may impede the acute effects of alcohol given its antiemetic properties (Söderpalm, Schuster, & de Wit, 2001). The reduced risk of vomiting when both substances are combined is of concern as likelihood of alcohol poisoning increases when the body is unable to rid itself of dangerous toxins. Given the different pharmacological effects and complex interactions between alcohol and marijuana, it is important to examine the effects of simultaneous use on different classes of consequences independently.

Potential Confounds

Between-subjects studies suggest that consequences are elevated among SAM users even when frequency of alcohol and/or marijuana use is controlled for (Subbaraman & Kerr, 2015). Alternatively, within-subjects studies suggest that associations may be attenuated or eliminated once there are controls for frequency (Lipperman-Kreda et al., 2017; Mallett et al., 2019). Psychosocial factors may also partially account for higher rates of problems among SAM users compared to other types of users (CAM and single-substance alone). For instance, indices of impulsivity such as sensation seeking and urgency (Bates, Labouvie, & White, 1986; Fischer, Smith, Spillane, & Cyders, 2005) are predictive of substance use outcomes including alcohol consequences (Magid, MacLean, & Colder, 2007; Stautz & Cooper, 2013) and marijuana consequences (Hayaki et al., 2011). Engagement in delinquent acts is another risk behavior common to both substance use and related consequences (Terry-McElrath et al., 2013; White & Gorman, 2000).

In addition to psychosocial factors, there are demographic characteristics that may confound the relationship between engaging in SAM use and experiencing negative consequences from alcohol and marijuana use. Males, compared to females, engage in greater SAM use (Lipperman-Kreda, Paschall, Saltz, & Morrison, 2018; Patrick, Terry-McElrath, Lee, & Schulenberg, 2019; Subbaraman & Kerr, 2015). There is also support (albeit inconsistent) for racial/ethnic group differences in SAM use (Lipperman-Kreda et al., 2017; Patrick et al., 2019; Subbaraman & Kerr, 2015). Additionally, age may be a factor given potentially different base rates of consequences for youth of legal drinking age (and for those with access to legalized recreational marijuana) compared to their younger peers.

Consequences: Attributions to Alcohol, Marijuana, or SAM Use?

Self-reported experience of a substance use-related consequence requires that the individual infer a causal connection between use of that substance use and the consequence. That is, a user who experiences an alcohol-related problem must perceive of it as the result of consuming alcohol as opposed to being due to some other source, such as fatigue or misfortune. The vast majority of the studies reviewed above have examined consequences of SAM use without asking respondents to attend to the substance they perceive to contribute to that consequence. For example, unsafe driving and cognitive problems are reported among SAM users without evaluating whether the user believes them to be consequences of the SAM use itself versus effects specific to alcohol use or marijuana use. Harrington et al. (2012) examined negative events as related to alcohol distinct from those related to marijuana, and Midanik et al. (2007) examined alcohol-attributed social consequences as a function of type of alcohol and marijuana use, but no studies have examined whether individuals who engage in SAM use infer a causal connection between their SAM use and resultant consequences. Although SAM users may experience more consequences than CAM or single-substance users even when controlling for quantity of use, SAM users may attribute these experiences solely to their alcohol use or their marijuana use as opposed to their simultaneous use per se. The majority of alcohol users who use marijuana do so only a few or some of the times that they drink (Terry-McElrath et al., 2013), which would make SAM occasions relatively more salient. On the other hand, the perceived source of consequences may reflect broader social, cultural, and campus norms about that substance (Kuendig et al., 2008). For example, individuals may be inclined to make attributions to alcohol because of the acceptability of exhibiting certain behaviors while under the influence of alcohol (Gmel, Kuntsche, Wicki, & Labhart, 2010). Thus, it is important understand whether a consequence is perceived to be an outcome of simultaneous use, alcohol use alone, or marijuana use alone.

Current Study

The present study has two research foci:

(1) We examine whether consequences are more likely to be experienced and if so, experienced more frequently, for past 3-month SAM users compared to users of alcohol alone and both alcohol and marijuana but not simultaneously (CAM users). For the present sample, the number of marijuana-only users was too small to make comparisons to users of marijuana alone. As SAM users are shown to be more frequent and heavier consumers of alcohol and marijuana, we account for both frequency and heaviness of alcohol and marijuana use. We also control for impulsivity and delinquency to provide a more rigorous test of associations between use and consequences than has been used in prior studies of consequences experienced by SAM users. While other studies have controlled for demographic differences and/or alcohol and marijuana use differences between SAM users and other types of users, no studies to our knowledge have controlled for personality/behavioral differences when comparing consequences experienced by SAM users to other types of users. We expect that even rigorously controlling for alcohol and marijuana consumption and confounding sociodemographic and psychosocial factors, SAM users, compared to other users, will report the greatest number of negative consequences.

(2) We examine whether consequences experienced by SAM users are more likely to be attributed to using alcohol, marijuana, or both simultaneously. We have no a priori expectations regarding the source to which consequences are attributed, given the lack of research on this topic.

For both research questions, we examine nine specific types of consequences: cognitive, blackout, vomiting, academic/occupational, social, self-care, physical dependence, risky behaviors, and driving under the influence.

Method

Design and Sample

A stratified (by year in school) random sample of students from three state universities was screened online for eligibility to participate in a web-survey in the fall of 2017 and again three months later in the winter of 2018. A total of 24,000 (8,000 at each university) e-mail invitations to participate in the screening survey were sent to students ages 18–24 years who were randomly chosen by each school's registrar based on expected year of graduation (i.e., 2,000 in each of the next four graduating classes). The three states had different laws regarding recreational marijuana use: School A is in a state where recreational marijuana is illegal, School B is in a state where marijuana is decriminalized, and School C is in a state where marijuana is legal for adults; medical marijuana is available in all three states.

Seven thousand students (29% of those invited) completed the screening survey (see White et al., 2019 for details on study method). Those completing the screening survey were fairly representative of the original invited random sample. Of those screened, 2,874 students met study eligibility criteria for the baseline survey: a) enrolled full-time at one of the three universities, b) ages 18–24 years old; c) past-year use of both alcohol and marijuana; d) verification of e-mail address; and e) contact information provided. Invitations to the baseline survey were stratified by school to facilitate equal participation across the three universities and resulted in 2,501 students being invited. A 30–45 min online survey was completed by 1,524 students (60.9% of those invited), but only 1,498 had usable data due to technical issues with 26 participants. After examining baseline responses, 1,390 were deemed eligible, as 108 students either reported no past-year alcohol use ($n = 27$ excluded) or no past-year marijuana use ($n = 77$ excluded) or were not full-time students ($n = 4$ excluded). No respondents were excluded due to failure on three attention checks.

The final sample ($n = 1,390$) was 62.4% female with a mean age of 19.8 ($SD = 1.3$); 63.8% were non-Hispanic white, 2.7% non-Hispanic black, 12.5% Asian, 12.2% Hispanic, 0.1% Native American, 0.2% Asian Pacific, 0.1% other, and 1.7% more than one ethnicity. Participants were roughly equally distributed across school (30.6% School A, 34.5% School B, 34.9% School C). Of the baseline sample, 89.8% ($N = 1,248$) completed the online

follow-up survey, and 1,235 provided nonmissing responses to past 3-month alcohol and marijuana use items. Attrition analyses indicated that there were no significant differences between those who completed the follow-up survey and those who did not in terms of school, sex, race/ethnicity, age, and past 3-month frequency of alcohol, marijuana, and SAM use. Because several of our key covariates (impulsivity and delinquency) were measured only at follow-up, the present study draws from follow-up data only.

All procedures were approved by the coordinating university institutional review board. A Certificate of Confidentiality was obtained from NIDA to preserve participant confidentiality. Students received gift cards for completing the baseline ($25) and follow-up ($35) surveys.

Measures

Alcohol and marijuana use. Students reported on the frequency of alcohol and marijuana in the past three months using an 8-point ordinal scale ranging from 0 = *did not use in the last 3 months* to 7 = *daily/more than daily*. Past 3-month frequency of SAM use was measured with the same response options and was worded: "How often did you use alcohol and marijuana at the same time so that their effects overlapped?" Variables were recoded to interval scales by taking the midpoint of the categories when appropriate and converting the ordinal frequencies to days per past three months (ranging from 0 to 90). We also assessed number of heavy episodic drinking (HED) episodes in the past 30 days, defined as five or more drinks per occasion for men and four or more drinks for women. Students completed an adapted version of the Daily Drinking Questionnaire (Collins, Parks, & Marlatt, 1985) for marijuana use, from which we obtained a measure of total number of hours high on marijuana per typical week.

Consequences. Students were provided with a list of negative consequences from the 24-item Brief Young Adult Alcohol Consequence Questionnaire (Kahler & Strong, 2006) and the 21-item Brief Marijuana Consequences Questionnaire (Simons, Dvorak, Merrill, & Read, 2012); collapsing the two scales yielded 28 unique items. Although the 28 items were identical, the instructions were tailored to the type of user. For past 3-month SAM users, items were preceded by:

> Below is a list of things that sometimes happen to people either during, or after they have been drinking alcohol or using marijuana. Please check whether or not these things have happened to you because of your alcohol use alone, your marijuana use alone, and/or because of using alcohol and marijuana together so that their effect overlapped in the past 3 months.

SAM users could endorse all three options (attribution to alcohol alone, marijuana alone, alcohol and marijuana together). Participants who reported past 3-month alcohol or marijuana use but either did not report using the other substance or did not use the two substances simultaneously in the past 3 months were asked about consequences specifically for alcohol or marijuana ("Below is a list of things that sometimes happen to people either during, or after they have been using [alcohol/marijuana]" please check whether or not these things have happened to you because of your [alcohol/marijuana] use in the past 3 months with the respective substance presented). For the first research question, we collapsed

consequences by combining any consequences endorsed regardless of substance attribution (Cronbach's alpha = .92). For the second research question (pertaining to SAM users only), we considered the three types of consequence attributions separately ($\alpha = .88$ for alcohol, $\alpha = .87$ for marijuana, and $\alpha = .88$ for SAM).

Personality and behavioral controls. We assessed three subscales from the UPPS-P Impulsive Behavior Scale (Lynam, Smith, Whiteside, & Cyders, 2006): positive urgency (e.g., "When I am very happy, I feel like it is ok to give into cravings or overindulge"), negative urgency (e.g., "When I am upset I often act without thinking"), and sensation seeking (e.g., "I enjoy taking risks"). In an effort to reduce participant burden, we selected the six items with the highest factor loadings from each of the original subscales, which had 12 items each for sensation seeking and negative urgency and 14 items for positive urgency. Response options included *disagreed strongly, disagreed some, agreed some*, or *agreed strongly*. Cronbach's alphas for the three subscales were: $\alpha = .81$, $\alpha = .83$, and $\alpha = .79$, respectively. We also included six items from the Self-Reported Delinquency Scale (Elliott, Huizinga, & Ageton, 1985). Students were asked whether they committed each of six delinquent acts (i.e., stolen things worth less than $50, stolen things worth more than $50, used a weapon in a fight, breaking and entering, destroyed property on purpose, and initiated fights) in the last 3 months. These six items were selected to reduce response burden, to be relevant for a college sample (in contrast to an adolescent delinquent sample or a sample of adult offenders), and to cover both person and property offenses. Because this measure was skewed due to low base rates on the items (ranging from 0.2% for using a weapon to 7.1% for petty theft), it was dichotomized into any delinquent act (coded 1; 12.3% of the sample) versus no delinquent acts (coded 0; 87.7% of the sample).

Sociodemographics. The baseline survey assessed birth sex (male, female) and gender (male, female, and other [which included trans male/trans man, trans female/trans woman, gender queer/gender nonconforming, different identity]), legal age status (categorized as under age 21 vs. age 21+ years old), racial group (Asian, Black, White, Mixed, and other), and ethnic group (Hispanic/Latinx vs. non-Hispanic/Latinx).

Analytic Plan

We first examined past three-month patterns of alcohol and marijuana use: no use of either ($n = 13$; 1.0%), alcohol use only ($n = 279$; 22.6%), marijuana use only ($n = 16$; 1.3%), CAM use only ($n = 249$; 20.2%), and SAM use ($n = 678$; 54.9%). Given the low base rates of no use and marijuana-only use, these two groups were dropped from subsequent analyses.

Consequences were divided into categories developed by Kahler, Strong, and Read (2005): academic and occupational problems (4 items, e.g., Have missed classes because of use, a hangover, or illness caused by use), social (3 items, e.g., My use has created problems between myself and my romantic partner or parents), self-care (5 items, e.g., I had less energy or felt tired because of my use), physical dependence (4 items, e.g., Could no longer get high on the amount that used to get me high), cognitive (3 items, e.g., Have passed out from using), and risk (4 items, e.g., Have taken foolish risks). Although Kahler and colleagues (2005)

collapsed blackout and vomiting with the other cognitive items, we examined the items "Have awakened the day after using and found I could not remember a part of the evening before" (i.e., blackout) and "Have felt very sick to my stomach or thrown up after using" (i.e., vomiting) independently. We made this decision because blackout is a highly endorsed and concerning consequence particularly related to drinking (Wetherill & Fromme, 2016), and vomiting is not a cognitive effect and may be reduced due to potential antiemetic effects of marijuana. We also examined driving under the influence (DUI; "Have driven a car while under the influence") independently of other risk problems because the robust literature on unsafe driving and SAM use highlights the importance of considering this outcome alone.

Given that the measure of consequences included a large number of zero values, we used a zero-inflated negative binomial (ZINB) model for our first research question, using maximum likelihood estimation with robust standard errors. This analysis permitted us to examine both the experience of any consequences (0/1; the zero-inflated portion of the model) as well as the range of consequences experienced (the count portion of the model). We tested all pairwise group comparisons (SAM vs. CAM; SAM vs. alcohol-only; CAM vs. alcohol-only) by altering the reference group. We explored whether or not each type of consequence was endorsed using logistic regression (there was insufficient variability in number of consequences experienced to use a negative binomial or ZINB model).

Adjusted analyses control for past three-month alcohol frequency, past 30-day HED frequency, past three-month marijuana frequency, and typical hours high on marijuana per week as well as sociodemographic variables (birth sex, legal age status, and non-Hispanic White vs. other) and psychosocial variables (urgency, sensation seeking, and delinquency). Because positive and negative urgency were highly correlated, we conducted parallel models with either negative urgency or positive urgency. Results presented in the paper include positive urgency, but findings remained the same when models were run with negative urgency instead. Site also was controlled (reference group: School B).

For our second research question, we included only those who engaged in SAM use ($n = 678$). We tested pairwise group differences in attribution source using McNemar's test of dependent group differences, comparing SAM versus alcohol, SAM versus marijuana, and alcohol versus marijuana among SAM users. We also report the difference between the proportions of discordant pairs, the recommended measure of effect size for the McNemar's test (NCSS, 2019), with effect sizes for values of 0.05, 0.15 and 0.25 corresponding to small, medium, and large effects, respectively. In all comparisons, we controlled for Type I error by adjusting our alpha ($\alpha = .05/9$ classes of consequences $= .0056$).

Results

Bivariate Associations

Descriptive information for sociodemographic factors, substance use, and psychosocial correlates is provided for each substance use group in Table 1. Group comparisons were made using chi square analysis and analysis of variance (ANOVA). SAM users, compared to both CAM and alcohol-only users, were more likely to report delinquency, higher positive urgency and negative urgency, sensation seeking (compared to alcohol-only users only), past three-month alcohol and marijuana frequency, past 30-day HED, more hours high on marijuana per week, and more frequent SAM use in the year prior to enrollment and were more likely to be male (compared to alcohol-only users). CAM users and alcohol-only users did not differ from each other on any of the demographic or psychosocial measures or on alcohol and marijuana consumption variables. There were no age group or gender differences; CAM users were more likely to be non-White and Hispanic than the other two user groups.

Table 1 also shows group differences in consequence scores. Without controls, SAM users reported significantly higher total consequence scores as well as higher alcohol-specific and marijuana-specific consequence scores than CAM users, who in turn reported higher total consequence scores than alcohol-only users.

Research Question 1: Multivariate Group Differences in Consequences Experienced

Full consequence scale. The ZINB model tested whether experiencing any consequence and number of consequences experienced significantly differed across group. Unadjusted ZINB models indicated that risk of experiencing any consequence was significantly greater for SAM and CAM compared to the alcohol-only group: $OR = 5.47$ (95% CI [2.89, 10.41]), $p < .001$; $OR = 3.70$ (95% CI [1.58, 8.73]), $p = .003$, respectively. There was no difference between SAM and CAM: $OR = 0.68$ (95% CI [0.27, 1.69]), $p = .40$. After adjusting for all covariates, however, there were no significant group differences in risk of experiencing any consequence: SAM versus CAM: $OR = 0.85$ (95% CI [0.29, 2.45]), $p = .76$; SAM versus alcohol-only: $OR = 2.02$ (95% CI [0.89, 4.60]), $p = .09$; CAM versus alcohol-only: $OR = 2.38$ (95% CI [0.94, 6.07]), $p = .07$. Greater number of hours high per week and being White were also associated with experiencing any consequence.

Number of consequences was highest for the SAM group ($M = 9.57$, $SD = 6.63$), followed by the CAM group ($M = 6.53$, $SD = 5.40$) and the alcohol-only group ($M = 4.28$, $SD = 4.04$). The unadjusted analyses indicated that SAM, compared to CAM, users reported a significantly greater number of consequences experienced: $IRR = 1.44$ (95% CI [1.29, 1.62]), $p < .001$. Compared to alcohol-only users, SAM users and CAM users each reported a significantly greater number of consequences: $IRR = 1.94$ (95% CI [1.73, 2.17]), $p < .001$; $IRR = 1.34$ (95% CI [1.16, 1.55]), $p < .001$, respectively. Adjusting for all covariates, SAM, compared to CAM, users reported a significantly greater number of consequences experienced: $IRR = 1.13$ (95% CI [1.01, 1.26]), $p < .05$. Compared to alcohol-only users, SAM users and CAM users reported a significantly greater number of consequences experienced: $IRR = 1.43$ (95% CI [1.25, 1.06]), $p < .001$ and $IRR = 1.26$ (95% CI [1.09, 1.43]), $p = .001$, respectively. Greater past 30-day frequency of heavy drinking and past three-month frequency of marijuana use, being delinquent, higher positive urgency, and being 21+ were significantly positively related to number of consequences.

Individual consequences. Table 2 presents the results of the adjusted logistic regression analyses for group differences in the prevalence of experiencing each type of consequence, controlling for

Table 1

Sociodemographic, Psychosocial, and Substance Use Differences Between SAM Users, CAM Users, and Alcohol-Only Users (N = 1,206)

Variable	χ^2 or F	Effect size (Φ or η^2)	SAM users ($N = 678$)	CAM users ($N = 249$)	Alcohol only users ($N = 279$)
School[#]	17.97**	.12			
A (illegal)			29.4%[a]	34.8%[b]	35.8%[b]
B (decriminalized)			35.3%	26.9%	38.8%
C (legal for 21[+])			36.0%	37.2%	26.8%
Birth sex[#]	5.63	.07			
Male			38.8%[a]	38.2%[a]	30.8%[b]
Female			61.2%	61.8%	69.2%
Gender[#]	9.03	.09			
Male			38.9%[a]	38.8%[a]	30.8%[a]
Female			59.5%	59.0%	67.7%
Other			1.6%	3.2%	1.4%
Age[#]	3.43	.05			
21[+]			32.7%[a]	31.7%[a]	38.4%[a]
Race[#]	16.31*	.12			
Asian			11.4%[a]	16.1%[b]	14.0%[a]
Black			3.3%	1.6%	4.3%
White			71.1%	61.7%	69.9%
Multi-racial			9.3%	12.9%	7.9%
Other			4.9%	3.9%	3.9%
Ethnicity[#]	9.18*	.09			
Hispanic/Latinx			12.2%[a]	17.3%[b]	8.6%[a]
Delinquent[#]	26.01***	.15			
Yes			16.7%[a]	8.4%[b]	5.4%[b]
Positive urgency[+]	8.91***	.02	11.4 (3.7)[a]	10.6 (3.5)[b]	10.4 (3.6)[b]
Negative urgency[+]	3.41*	.01	12.2 (4.1)[a]	11.5 (4.2)[b]	11.6 (4.2)[b]
Sensation seeking[+]	6.72**	.01	15.5 (4.1)[a]	14.9 (4.4)[ab]	14.4 (4.1)[b]
3-mo frequency alcohol use[+]	34.73***	.05	20.2 (16.7)[a]	12.3 (12.5)[b]	13.4 (13.4)[b]
30-day freq heavy drink[+]	33.76***	.05	4.0 (4.1)[a]	2.4 (3.4)[b]	2.2 (2.9)[b]
3-mo freq marijuana use[+]	82.71***	.08	33.6 (33.6)[a]	12.6 (22.9)[b]	—
Hours high typical week[+]	68.94***	.07	11.7 (13.6)[a]	4.2 (6.4)[b]	—
Past-year freq SAM use[+†]	35.49***	.10	26.90 (42.68)[a]	4.93 (9.62)[b]	4.13 (7.15)[c]
Total consequences[+]	74.39***	.11	8.8 (6.1)[a]	6.0 (4.9)[b]	4.3 (4.0)[c]
Alcohol-attributed conseq[+]	7.36***	.01	5.4 (4.7)[a]	4.7 (4.7)[b]	4.3 (4.0)[b]
Marijuana-attributed conseq[+]	25.71***	.03	3.5 (4.0)[a]	2.1 (2.9)[b]	—
SAM-attributed conseq[+]	—	—	2.3 (3.4)	—	—

Note. Means in a row without a common superscript letter significantly differ at $p < .05$. Other gender includes trans male/trans man, trans female/trans woman, gender queer/gender non-conforming, different identity. Other race includes American Indian, Pacific Islander, and "Other." Freq = frequency; Conseq = consequence score; SAM = simultaneous alcohol and marijuana; CAM = concurrent alcohol and marijuana.
[#] Percentages, chi-square coefficients, and phi coefficients presented.   [+] Means (and standard deviations), F-tests ($df = 2, 1203$), and eta-squared presented.   [†] Assessed at baseline.   * $p < .05$.   ** $p < .01$.   *** $p < .001$.

the same set of variables as the analysis for the full consequence scale. There was a higher prevalence of experiencing a cognitive consequence, experiencing a blackout, vomiting, experiencing a social consequence, engaging in a risky behavior, engaging in DUI, and experiencing a physical dependence-related consequence for SAM users compared to alcohol-only users, even adjusting for alcohol and marijuana use and sociodemographic and psychosocial variables. Compared to alcohol-only users, CAM users were significantly more likely to experience a cognitive consequence, vomit, engage in a risky behavior, and engage in DUI. None of the tests of differences in consequence types between SAM and CAM groups were significant, with the exception of blackout.

Unadjusted models revealed that group comparisons for SAM (vs. CAM or alcohol-alone) were significant ($p < .0056$) for experiencing eight of the nine consequences, with the only exception that social and risk-related consequences did not differ for the SAM-CAM comparison only. CAM and alcohol-only groups differed on all outcomes with the exception of self-care. Unadjusted odds ratios ranged from 1.60 (academic/occupational) to 10.44 (DUI). The full set of unadjusted results are presented in Table S1 in the online supplemental materials.

Finally, we ran a sensitivity analysis to examine whether observed group differences in experiencing consequences were robust to the degree of SAM use. To do so, we parsed the SAM user category into frequent and infrequent SAM users, categorizing those engaging in SAM use more than monthly in the past three months (24% of the SAM users) as frequent SAM users and the remainder (once a month or less often; 76%) as infrequent SAM users. Not surprisingly, frequent SAM users ($M = 13.06$; $SD = 7.22$) reported more consequences than infrequent SAM users ($M = 8.47$; $SD = 6.03$).

Our models for types of consequences were reestimated using four groups (frequent SAM, infrequent SAM, CAM, and alcohol-only; results not shown). Findings revealed that although the

Table 2

Prevalence and Tests of the Association of SAM Group With Experiencing Consequences (N = 1,206)

	Endorsement			OR (95% CI)		
Consequence	SAM (n = 678)	CAM (n = 249)	Alc only (n = 279)	SAM vs CAM	SAM vs Alcohol	CAM vs Alcohol
Any cognitive	85.1%	77.5%	63.1%	1.11 [.74, 1.67]	2.23 [1.49, 3.33]*	2.00 [1.33, 3.02]*
Blackout	55.8%	37.0%	28.3%	1.71 [1.22, 2.40]*	2.64 [1.84, 3.78]*	1.54 [1.05, 2.28]
Vomit	64.9%	53.0%	39.8%	1.28 [.93, 1.78]	2.17 [1.54, 3.06]*	1.69 [1.18, 2.42]*
Any academic/occupation	42.2%	31.3%	18.6%	.89 [.62, 1.27]	1.56 [1.04, 2.34]	1.76 [1.14, 2.72]
Any social	67.7%	58.2%	45.9%	1.18 [.84, 1.66]	1.92 [1.36, 2.71]*	1.62 [1.13, 2.34]
Any self-care	79.8%	67.5%	60.2%	1.27 [.87, 1.86]	1.53 [1.04, 2.24]	1.20 [.82, 1.77]
Any risk	55.3%	47.4%	33.3%	.96 [.69, 1.33]	1.72 [1.20, 2.45]*	1.79 [1.23, 2.61]*
Driving under influence	35.6%	18.5%	5.0%	1.37 [.92, 2.04]	4.66 [2.56, 8.50]*	3.41 [1.78, 6.53]*
Any physical dependence	63.0%	42.6%	25.8%	1.28 [.92, 1.80]	2.10 [1.46, 3.04]*	1.64 [1.10, 2.43]

Note. Alc = Alcohol; SAM = simultaneous alcohol and marijuana; CAM = concurrent alcohol and marijuana. Tests of group differences control for school, sex, race/ethnicity, age (21+ vs. under 21), positive urgency, sensation seeking, delinquency, past 3-month frequency of alcohol use, past 30-day frequency of heavy drinking, past 3-month frequency of marijuana use, and hours high from marijuana use per typical week.
* $p < .0056$.

magnitude of effects was somewhat larger for the frequent SAM comparisons than the infrequent SAM comparisons, results were largely unchanged. All tests of SAM–CAM differences were replicated, as were the SAM–alcohol alone comparisons for the infrequent SAM group. The comparison between frequent SAM and alcohol-only groups no longer reached significance for social and risk outcomes, and a significant effect emerged for academic/occupational consequences, although the overall magnitude of that effect was still lower than that of cognitive and DUI effects. Thus, group differences in consequences experienced appear to be robust to frequency of SAM use.

Research Question 2: Differences in Attributions Among SAM Users

McNemar's test of dependent group differences indicated significant differences in attribution to different substances among SAM users (see Table 3). The table also shows effect sizes for tests of group differences as well as endorsement of consequences for alcohol, marijuana and SAM attributions for each class of consequence. For example, SAM users were significantly more likely to attribute cognitive-related consequences to SAM use (39.8%) versus marijuana alone (28.3%) but were most likely to attribute cognitive-related consequences to alcohol alone (79.4%; $p < .001$). We observed significant within-subjects group differences for virtually all consequences. Each type of consequence was attributable to alcohol to a much greater extent than to SAM use. Attributions to marijuana were also greater than to SAM use for all consequences except cognitive, blackout, and social, which SAM users more often attributed to their simultaneous use. Finally, consequences were more attributable to alcohol than marijuana with the exception of DUI and physical dependence, where attributions were greater for marijuana than alcohol, and self-care, which was attributed to alcohol and marijuana at equal rates.

Table 3

Endorsement and Tests of Differences of Alcohol, Marijuana, and SAM Attributions Among Those Who Engaged in Past 3 Month SAM Use

	Endorsement			McNemar's Test of dependent group differences[a] and effect size[b]					
				SAM vs Alcohol		SAM vs Marijuana		Alcohol vs Marijuana	
Consequence	Alcohol attribution	Marijuana attribution	SAM attribution	Test	ES	Test	ES	Test	ES
Any cognitive	79.4%	28.3%	39.8%	238.58	−.39	37.44	.16	365.53	.55
Blackout	54.0%	7.3%	20.3%	216.41	−.29	75.92	.13	350.78	.42
Vomit	63.3%	20.4%	17.6%	310.00	−.46	19.00	−.03	270.55	.43
Any academic/occupational	29.2%	20.6%	14.2%	58.45	−.15	14.89	−.06	18.28	.09
Any social	55.5%	19.9%	27.0%	118.25	−.29	13.71	.07	195.56	.36
Any self-care	50.9%	53.7%	35.1%	41.33	−.16	64.02	−.19	1.16	−.03
Any risk	48.8%	37.2%	17.6%	161.67	−.31	85.45	−.20	22.69	.12
Driving under influence	9.9%	33.3%	5.0%	33.00	−.05	192.00	−.28	133.76	−.23
Any physical dependence	30.5%	49.1%	16.7%	45.55	−.14	164.53	−.32	59.68	−.19

Note. n = 678, df = 1; ES = effect size; SAM = simultaneous alcohol and marijuana; CAM = concurrent alcohol and marijuana.
[a] All McNemar's Tests were significant at $p < .001$ with the exception of alcohol vs. marijuana for self-care ($p = .28$). [b] The measure of effect size for the McNemar's Test is the difference between the proportions of discordant pairs. Negative values indicate that the reference group is more highly endorsed (e.g., alcohol is more highly endorsed than SAM).

Finally, given that more frequent attribution of consequences to alcohol could be due to a greater number of drinking occasions when alcohol is consumed alone than when alcohol is combined with marijuana, sensitivity analyses were conducted to examine attributions separately for those with frequent SAM use (more than monthly) versus infrequent SAM use (monthly or less often), among respondents who drank at relatively high levels (defined as bi-weekly drinking or more often) to control for amount of alcohol use. The relative magnitude and rank ordering were very similar for those with frequent SAM use and infrequent SAM use (see Table S2 in the online supplement materials), although endorsement of consequences across the board was higher for those with more frequent SAM use. Thus, the degree to which one's drinking experiences include marijuana (SAM frequency) does not seem to account for the pattern of attributions observed.

Discussion

The present study demonstrated that college students who reported past three-month use of alcohol and marijuana simultaneously (i.e., so that the effects overlapped) experienced more negative consequences relative to those who reported past three-month use of alcohol only as well as those who reported using both alcohol and marijuana but not at the same time. This was true even adjusting for consumption and personality and behavioral indicators of impulsivity (urgency, sensation seeking, delinquency) and sociodemographic differences (sex, race/ethnicity, legal age status) that could explain consequences of both alcohol and marijuana use. Because of these controls, the results suggest that it is the combined use of alcohol and marijuana that accounts for an overall increased number of consequences rather than merely the underlying extent of use or characteristics of individuals who combine the two substances. Although we were unable to control for all possible unobserved difference among groups of users, this is the most comprehensively controlled test of these differences to date.

Whether or not a single consequence was reported did not vary across simultaneous use status, even in unadjusted models, whereas greater frequency of experiencing consequences was evident for SAM users relative to CAM users. Although we did not see differences based on frequency of SAM use, there may be some threshold of simultaneous use frequency above what is present in this sample (e.g., once or twice a week) that needs to be met before consequences are experienced. Even in this sample selected for past-year alcohol and marijuana use, more than three fourths of SAM users engaged in SAM use on a monthly or less frequent basis. Further, although CAM users did not report greater alcohol consumption than alcohol-only users, they reported experiencing more overall consequences, even adjusting for the set of sociodemographic and psychosocial correlates. Thus, there is added risk for using both substances at different times. Essentially, being a user of both alcohol and marijuana and using alcohol and marijuana so that the effects overlap each contribute to public health harms, suggesting there is value in targeting the mechanisms underlying type of user as well as type of use within a person.

Individual Consequences: Likelihood and Attributions

In contrast to the findings for overall consequences experienced, experiencing each of nine specific types of consequence did not differ for simultaneous users versus concurrent users once differences in level of alcohol and marijuana use and other confounding factors were adjusted. However, we replicated prior literature in showing that SAM users were much more likely to experience a given negative consequence relative to those who consumed alcohol alone. Although the present study cannot distinguish between negative consequences experienced at times when alcohol and marijuana were combined versus when they were used alone, the results of our second research question suggest that among SAM users, negative consequences were far more likely to be attributed to alcohol than to SAM use or marijuana. That is, SAM users may believe (correctly or not) that consuming alcohol alone can result in worse outcomes than specifically drinking when also consuming marijuana. Although previous research demonstrates that high school students (Patrick et al., 2018) and veterans (Metrik, Gunn, Jackson, Sokolovsky, & Borsari, 2018) drink more alcohol on days that they use alcohol and marijuana than on days when they only consume alcohol, there may be a riskier pattern of drinking when using alcohol alone. For example, there may be a faster rate of consumption (due to a shorter duration between drinks, drinking on an empty stomach) when using alcohol alone compared to drinking when using with marijuana. Similarly, there may be a difference in type of beverage (e.g., consuming a shot or large pour of liquor on its own vs. consuming a low alcohol content beer while smoking a joint). We controlled for heavy drinking in the analyses, but risky consumption may be more than simply number of drinks per se. This finding is consistent with event-level data from the same sample as the present study, which demonstrated that heavier alcohol consumption is associated with more same-day consequences but this association was mitigated when marijuana was used in a 3-hr window (Sokolovsky, Gunn, Micalizzi, White, & Jackson, 2019). Alternately, participants may be misattributing the source of their consequences, perceiving the problem to be primarily the result of their drinking rather than their combined use of alcohol with marijuana. SAM users rarely attributed consequences experienced to simultaneous use per se; in fact, SAM use was the least endorsed source of all types of consequences more often than not. It may be tasking the individual too much to ask them to make broad attributions as opposed to asking them to think about a single event.

Driving under the influence. The greatest difference between simultaneous users and alcohol-only users was found for driving a car while under the influence. Driving under the influence was far more likely to be reported by individuals who reported consuming alcohol at the same time as the marijuana (36% endorsed DUI) than those who consumed alcohol alone (5%). These findings extend prior work in other populations that has documented higher rates of unsafe driving in simultaneous users relative to alcohol-only users, including in samples of adolescents (Lipperman-Kreda et al., 2017; Terry-McElrath et al., 2014), young adults (Duckworth & Lee, 2019), and adults (Subbaraman & Kerr, 2015). We extend prior work by including rigorous controls in the models, including controlling for consumption, which suggests that risk of engagement in unsafe driving is not simply due to greater rates of drinking or risk-taking tendencies among SAM users.

Although DUI endorsement was greater for SAM users than CAM users, this difference was not significant after adjusting for consumption and confounding variables. It is possible that driving under the influence occurs more frequently for SAM users than CAM users, but

our analyses only considered whether or not the consequence was experienced. Our second research question demonstrated that among SAM users, driving under the influence was more likely to be attributed to marijuana use than alcohol or simultaneous use; that is, more students reported driving under the influence of marijuana than under the influence of alcohol (alone or combined). We found this somewhat surprising as we would have expected SAM users to attribute driving under the influence to SAM use. It is possible that this current generation, which has been socialized not to drink and drive, is unlikely to drive under the influence of alcohol (or to report doing so) whether used alone or in combination with marijuana. However, such norms have not been developed for marijuana. Although risks regarding driving following consumption of alcohol have been a focus of public service messages for some time, similar campaigns have not yet been launched for marijuana (Aston, Merrill, McCarthy, & Metrik, 2016). Relative to driving after alcohol use, college students and young adults perceive driving after marijuana use as lower risk and more acceptable to peers (Duckworth & Lee, 2019; McCarthy, Lynch, & Pederson, 2007) and the negative consequences as less likely, even after controlling for substance use (McCarthy et al., 2007). Had we had asked about negative consequences related to driving (e.g., ticket, accident), we might have found the opposite; that is, more problems would be attributed to SAM use than marijuana use alone due to the additive effects of alcohol and marijuana on driving ability. This possibility is supported by a recent study by Duckworth and Lee (2019) showing higher scores on a composite of risky driving behaviors for SAM users relative to CAM or single-substance users.

Cognition-related consequences. Cognitive problems (e.g., haven't been as sharp mentally because of my use; have woken up in an unexpected place after using heavily) were higher for those who used alcohol and marijuana simultaneously, relative to those who used alcohol alone. Lee and colleagues found that young adults perceive greater clumsiness, confusion, dizziness, difficulty concentrating, and feeling drunk on SAM use occasions compared to alcohol or marijuana only occasions (Lee, Cadigan, & Patrick, 2017). Consuming alcohol while using marijuana increases the concentration of THC in the user's blood (Hartman, Brown, Milavetz, Spurgin, Gorelick, et al., 2015) and may cause more THC to reach the brain via the bloodstream, thereby magnifying the usual effects of marijuana (Lukas & Orozco, 2001). In line with the study by Mallett et al. (2017) showing greater rates of blackout after use of both alcohol and marijuana on an occasion relative to use of alcohol alone, users of both substances were more likely than alcohol-users to indicate that they could not remember a part of the prior evening due to their use. Moreover, having a blackout was the only specific consequence to show a difference between SAM and CAM users. There seems to be something unique about engaging in simultaneous alcohol and marijuana use that significantly increases likelihood of blackout; engaging in alcohol and marijuana use at different times does not pose additional risk. We believe these findings will be informative for researchers and practitioners who are specifically interested in the risk of blackout. More fine-grained data that measure whether acute consequences follow consumption of alcohol, marijuana, or both (simultaneously or not) would be informative and are a direction of our current research.

Vomiting. Although we had hypothesized that vomiting would be less likely to be reported by simultaneous users because of marijuana's antiemetic effect (Söderpalm et al., 2001), vomiting was reported more frequently by simultaneous users. These effects are not necessarily incompatible; it may be that at the between-person level, substance use takes a different pattern for SAM users (e.g., a risky pattern of drinking not captured by our broad measures of alcohol frequency and heavy drinking) but at the within-person level, marijuana would buffer the effect of alcohol. Consistent with this notion, among SAM users, vomiting was more likely to be attributed to alcohol or marijuana than to SAM use. As with other consequences, event-based data or alcohol and marijuana-administration laboratory studies may be necessary to resolve this issue.

Social. Social problems were also evident for simultaneous users, with greater endorsement relative to alcohol users. These findings are consistent with work showing substantially greater social consequences (e.g., said or did embarrassing things or said harsh or cruel things) when alcohol was consumed with marijuana than when consumed alone both at the between-person level (comparing users; Subbaraman & Kerr, 2015) and at the within-person level (comparing occasions or days; Mallett et al., 2017, 2019). SAM users did not differ from CAM users, however, even in unadjusted analyses. Social consequences were least likely to be attributed to marijuana. Marijuana may reduce some of the interpersonal/social problems often attributed to alcohol by causing the user to become less aggressive (Boles & Miotto, 2003; Miczek et al., 1994).

Physical dependence. Symptoms of physical dependence also were more likely to be experienced among SAM users than alcohol-only users, and among SAM users, were more likely to be attributed to marijuana than to alcohol. This finding is somewhat surprising given the public (mis)perception that marijuana is not addictive. It may be that SAM users (who use marijuana more frequently than other students) perceive themselves to be more dependent on marijuana than on alcohol. Alternately, the items in the physical dependence scale may be more relevant for marijuana in this sample of college students; for example, use "after I'd gotten up (i.e., before breakfast)" may be more highly endorsed for marijuana, which tends to be used throughout the day (Buckner, Crosby, Silgado, Wonderlich, & Schmidt, 2012), as opposed to alcohol, which is typically consumed on weekends and in the evenings.

Strengths and Limitations

This is the first study to examine whether users of alcohol and marijuana were more likely to experience negative consequences when they report a history of consuming the two substances simultaneously, rigorously controlling for frequency and intensity of consumption and individual differences in impulsivity and delinquency, two robust risk factors accounting for problematic substance use. We examined the experience of any consequence and number of consequences experienced as well as nine different consequence classes. We documented additional risks experienced by SAM users over alcohol alone, and extending the literature, we also tested differences between SAM and CAM users. We focused on a population of recent users of both alcohol and marijuana who may be at greater risk for experiencing negative outcomes of substance use than more intermittent users or users of a single substance alone. In addition, we included students attending three state universities in states with varying marijuana laws, thus increasing generalizability. This is also the first study to examine the perceived source of consequences experienced by asking SAM users to make attributions to type of substance.

At the same time, study findings should be interpreted in the context of several limitations. We were unable to compare SAM users to marijuana-only users as there were few students ($n = 16$) reporting consuming marijuana but not alcohol in the past three months, consistent with the universally high rates of drinking among college students. In addition, this sample was selected based on their report of past-year alcohol and marijuana use at baseline and will not necessarily generalize to other college students, noncollege attending youth, or other age groups. Thus, findings should be replicated in different contexts and populations who may experience different types of consequences. Whereas the prevalence of SAM use was relatively high, the frequency of SAM use was relatively low in this sample, with SAM use reported occurring monthly or less often for the majority (76%) of the SAM-using sample. Our classification of SAM based on past three-month use was consistent with our measure of consequences but failed to consider SAM use prior to that time period. Indeed, 137 of 249 (55.0%) past-3 month CAM users endorsed past-year SAM use at baseline, as did 137 (49.1%) alcohol-only users. Thus, our tests of association are likely conservative estimates.

We adapted Kahler et al's (2005) categories for examining types of consequences, which were developed based on a much longer list of consequences. Therefore, some of our consequence subscales contained few items. Our findings should be replicated with more reliable measures of these constructs. The study relied on a student's ability to make a connection between a consequence and use of a substance, and further, on their ability to assess whether a problem occurred due specifically to their use of alcohol or marijuana alone or due to combined use. Further, we could not verify whether alcohol, marijuana or SAM use caused the consequence, and there is no way to determine whether the student was correct in their attribution. Nonetheless, one might argue that a misperception is as important to consider as an accurate attribution, especially given its implications for prevention. Finally, we generalized from people (simultaneous users) to processes (simultaneous use), and it is critical that our research questions be further investigated using event-based, fine-grained data.

Study Implications

Findings support the need for multisubstance prevention programs (Leatherdale & Ahmed, 2010), and within these programs, content specific to simultaneous use. For example, teaching students to avoid combining alcohol with marijuana is one of the recommended protective behavioral strategies associated with serious harm reduction (Treloar, Martens, & McCarthy, 2015), and we recommend that it be included in college substance use programs. Furthermore, attributions about the sources of consequences may be an effective target for prevention, for example, through content that elicits cognitive reappraisal. Students who experience a negative consequence due to their simultaneous use may misattribute that consequence to alcohol alone because they perceive that marijuana is a "safe" substance (Sarvet et al., 2018), possibly because the media has desensitized the public to marijuana-related harms (McGinty et al., 2016).

A call for understanding and reducing heavy alcohol consumption on college campuses has yielded many efficacious and disseminable prevention and treatment programs (Scott-Sheldon, Carey, Elliott, Garey, & Carey, 2014) such as brief motivational

interventions (Tanner-Smith & Lipsey, 2015). College students are now inundated with the message that heavy drinking can result in adverse outcomes, often before they even set foot on campus. Few such messages about the negative effects of marijuana use are being communicated on college campuses. Likewise, risks associated with driving under the influence of marijuana have been little acknowledged in this cohort, which grew up with alcohol-specific drunk driving campaigns (Fell, Scherer, Thomas, & Voas, 2016). As a result, students may be attributing consequences primarily to their drinking because they have internalized the message that alcohol can lead to these negative outcomes. Fortunately, it may be easier to shift cognitive perceptions among college students regarding marijuana use because cultural and college-based norms are not yet fully established. Thus, there is great promise in the development of prevention programs that focus on changing perceptions regarding marijuana use and, especially, using alcohol and marijuana simultaneously.

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