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Alcohol and Cannabis Use among College Students: Substitutes or Complements?

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Abstract

Aims—Economists debate whether changes in availability of alcohol or cannabis are positively or negatively related to changes in use of the other substance. Implicit in these arguments are two competing, individual-level hypotheses—that people use alcohol and cannabis either as complements or substitutes for one another. This is the first study to test these hypotheses using micro-longitudinal data on individuals' alcohol and cannabis use on a given evening.

Methods—United States college students who use alcohol and cannabis ($n = 876$) were selected from a larger sample who participated in a 30-day online daily diary study. At baseline, students reported their proclivity to use alcohol/drugs to cope with stress. Each day students reported their level of alcohol use from the prior evening as well as whether they had used cannabis.

Results—Evening levels of alcohol use and mean levels of alcohol use positively predicted the likelihood of evening cannabis use, results indicative of complementary use. This relation, however, was moderated by coping style, such that students who were more likely to use alcohol/ drugs to cope were less likely to use cannabis as their evening or mean alcohol use levels increased, results indicative of substitution.

Conclusions—Substance-using college students showed evidence for complementary alcohol and cannabis use at both the within- and between-person levels. Students with a proclivity toward using alcohol/drugs to cope, however, showed evidence of substitution. These findings suggest

that studies based on economic theories of substance use should take into account individual differences in substance use motives.

Keywords

Alcohol; Cannabis; College student; Substitution; Complement; Coping

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> *Cannabis sativa and its derivatives are strictly prohibited in Turkey, and the natural correlative of this proscription is that alcohol, far from being frowned upon as it is in other Moslem lands, is freely drunk*
>
> ~*Paul Bowles (1963)*

> Rollin' down the street, smokin' indo, sippin' on gin and juice / Laid back (with my mind on my money and my money on my mind)
>
> ~Snoop Dogg (1994)

1. Introduction

For nearly 30 years, economists have debated whether alcohol and cannabis act as substitutes or complements to one another. In a substitute relationship, factors that inhibit availability of one substance, such as increased price or legal restrictions, lead to increases in use of the other (as in the above quote regarding hashish restrictions in Turkey). In a complementary relationship, however, factors that influence the availability of one substance have a parallel effect on use of the other (e.g., decriminalization of cannabis leading to increased alcohol consumption; Cameron & Williams, 2001). Implicit in these competing hypotheses are untested assumptions about how individuals behave with regard to alcohol and cannabis use. The substitution hypothesis assumes that substance-using individuals consume the more readily available drug and neglect the less available one. In such instances individuals may have instrumental reasons for using (e.g., self-medication, tension reduction, or stress dampening; Greeley & Oei, 1999; Khantzian, 1997; Sher, Bartholow, Peuser, Erickson, & Wood, 2007) that they fulfill through the most convenient means (Stone & Kennedy-Moore, 1992). The complement hypothesis, however, assumes that individuals tend to use alcohol and cannabis together within a fixed, limited time period (e.g., during the same evening). In this case, substances may be part of a common social experience (as eloquently related in Snoop Dogg's "Gin and Juice") or produce desired interactive effects (e.g., euphoria). Limiting availability of one substance, therefore, inadvertently cuts off access to the other substance or makes it less desirable.

Understanding the relation between alcohol and cannabis is key to predicting the overall impact on public health that may result due to changes in substance use policy, which is especially important in light of increasingly liberal attitudes toward cannabis legalization (Vitale, 2014). While support exists for both substitute and complement relations, evidence for each stems mainly from macro-level economic or epidemiological data; no research to date has examined the assumptions underlying these hypotheses at the individual level. This is the first study, therefore, to assess whether alcohol and cannabis serve as substitutes or complements during discrete episodes of substance use. We tested these competing hypotheses among United States (U.S.) college students, as alcohol and cannabis are the

most commonly used substances on college campuses (Arria et al., 2008; Caldeira, Arria, O'Grady, Vincent, & Wish, 2008; Knight et al., 2002; Wechsler et al., 2002), and over one-quarter of students co-use these substances (Shillington & Clapp, 2006). Moreover, students who use alcohol or cannabis report an array of academic and social problems stemming from their use (Arria et al., 2013; Caldeira et al., 2008; Merrill & Read, 2010). Findings from this sample, therefore, would be particularly informative for developing policies and interventions to curb substance use on college campuses.

Multiple studies have supported the substitution hypothesis by showing that policy changes that restrict access to one substance predict increased use of the other. For example, raising the minimum legal drinking age to 21 has been associated with increased cannabis use among U.S. high school seniors (DiNardo & Lemieux, 2001). Moreover, data from the National Survey of Drug Use and Health showed that U.S. alcohol use tends to spike at age 21 (the minimum legal drinking age), whereas cannabis use shows a stark decrease and steady decline at age 21 (Crost & Guerrero, 2012). Increases in the price of alcohol, likewise, have been linked to increased cannabis use in Australia (Cameron & Williams, 2001). In the reverse direction, decriminalizing cannabis use in the U.S. has been associated with decreased drinking (Saffer & Chaloupka, 1999), and legalizing medical marijuana predicted a nearly 15% decrease in alcohol-related traffic fatalities in the 3 years post-legalization (Anderson, Hansen, & Rees, 2013).

Evidence from the coping literature suggests that substitution may be most likely to occur among those who use alcohol or drugs to cope with negative affect. The desire to alleviate or numb unpleasant feelings is a key motivation for both cannabis and alcohol use (Simons, Correia, & Carey, 2000). Multiple theories of alcohol use posit that drinking is often a means of reducing stress or tension, alleviating negative affect, or self-medicating (Cooper, Frone, Russell, & Mudar, 1995; Greeley & Oei, 1999; Khantzian, 1997; Sher et al., 2007). Likewise, cannabis appears to be used primarily as a means of tension-reduction or self-medication, as it is anxiolytic (Bergamischi et al., 2011; Crippa et al., 2011) and reasons for using such as relaxation and stress-reduction are frequently reported (Beck et al., 2009; Brodbeck, Matter, Page, & Moggi, 2007; Lee, Neighbors, & Woods, 2007). Importantly, college students are at particular risk for using substances to cope (Park & Levenson, 2002), which heightens their risk for substance-related problems (Cooper et al., 1995; Simons, Gaher, Correia, Hansen, & Christopher, 2005). Germane to our competing hypotheses, individuals who cope using one strategy tend not to engage in subsequent coping behaviors if the first action proved satisfactory (Stone & Kennedy-Moore, 1992). This finding suggests that students with a proclivity to cope using alcohol/drugs may be more likely to exhibit substitution; individual differences in coping style, therefore, emerge as an important potential moderator.

Other evidence, however, supports the complement hypothesis. For example, increases in the cost of alcohol have been associated with decreases in cannabis use among U.S. adolescents and young adults (Farrelly, Bray, Zarkin, Wendling, & Pacula, 1999; Pacula, 1998). Moreover, increases in alcohol prices and fines for heavy intoxication have been linked with decreased cannabis use in Australia, especially among individuals who use these substances concurrently (Williams & Mahmoudi, 2004). Of particular interest, higher

alcohol prices and alcohol-restrictive policies, specifically regulating happy hours and banning alcohol on campus, have been associated with decreased cannabis use across U.S. colleges (Williams, Pacula, Chaloupka, & Wechsler, 2004).

Both physiological and social mechanisms have been proposed to explain why alcohol and cannabis might be used in a complementary fashion (Hall & Lynsky, 2005). Animal models demonstrate that most drugs produce similar reward effects in the dopaminergic system. The euphoria induced by one drug, therefore, may increase sensitivity to other substances, thus producing a pattern of complementary use. Moreover, decreased use of one drug could extinguish reward associations common across substances. It is also likely that alcohol and cannabis use occur in shared social settings where co-use becomes more likely due to shared availability. Given that social motives underlie much substance use on college campuses (Beck et al., 2009; Christiansen, Vik, & Jarchow, 2002; Lee et al., 2007), one may expect complementary use as part of this social milieu.

The ambivalence of the evidence—including studies that indicate asymmetrical, limited, or non-existent associations between alcohol use and other drug consumption (Krauss, Cavazos-Rehg, Agrawal, Bierut, & Grucza, 2015; Petry, 2001; White et al., 2015)—calls for further research using different methodologies to understand these relations. Examining these hypotheses at the individual level represents such an advance in our understanding. Although economic theories assume an individual-level association between these two substances, analyses at these more macro-levels cannot support such interpretations. Furthermore, both hypotheses may be true under certain circumstances, and within-person analyses present a better opportunity to explore individual differences that may shed light on when and for whom each hypothesis is correct. Identifying how efforts to curb substance use may be received by different subgroups is paramount to designing policies and interventions that provide the greatest benefit to the widest audience.

The goal of the current study, therefore, was to examine associations between proximal use of both alcohol and cannabis in a substance-using, U.S. college sample, as well as how this relation differs by individuals' general motivation to use substances to cope with stress. According to the substitution hypothesis, on evenings when students consume more alcohol than usual, we would expect to see lower odds of using cannabis. The complement hypothesis, however, would predict that on evenings of higher-than-usual alcohol use, the odds of cannabis use would be greater. Moreover, we expect to find stronger evidence of substitution among students who report using alcohol/drugs to cope. To test these hypotheses, we conducted a 30-day online daily diary study, a design well-suited for capturing discrete behaviors such as cannabis and alcohol use that tend to be memorable and time-limited (Gunthert & Wenze, 2012).

2. Method

2.1. Participants

The institutional review board at the University of Connecticut—a large, rural, state university in the northeastern U.S—approved all procedures. From 2008 to 2012, we recruited 1,818 students through the undergraduate psychology participant pool and campus-

wide emails. Eligible students were at least 18 years old, had consumed alcohol at least twice in the past 30 days, and had never undergone treatment for alcohol problems (measured during prescreening). Students were excluded from analyses if they failed to provide at least 15 daily surveys ($n = 177$) or did not complete the COPE Inventory ($n = 5$). Of the 1,636 students who followed protocol, we selected for analysis the 876 students (54%) who reported cannabis use during the past year or who used during the diary study. The sample for analysis completed 22,557 diaries ($M = 25.8$, $SD = 4.0$), included 444 men and 432 women, was primarily European American (85%), and had an average age of 19.2 years ($SD = 1.2$). Compared to the full sample, students included in analyses were more likely to be male, $\chi^2(1) = 14.8$, $p < .001$; European American, $\chi^2(1) = 33.7$, $p < .001$; younger, $t(1443) = 1.97$, $p = .049$; and reported higher proclivity to cope using alcohol/drugs, $t(1485) = 14.52$, $p < .001$.

2.2. Measures

At baseline, students completed the 60-item COPE Inventory, which asked them to rate how frequently they respond to stressful events in different ways, using a scale from 0 = *not at all* to 3 = *a lot* (Carver, Scheier, & Weintraub, 1989). Proclivity to use alcohol or drugs to cope was measured with four items: "I use alcohol or drugs to get me through," "I try to lose myself for a while by drinking or taking drugs," "I drink alcohol or take drugs in order to think about it less," and "I use alcohol or drugs to make myself feel better." Responses to these four items were summed, $\alpha = .95$.

Evening cannabis use was measured each day by asking whether students had used marijuana last night (*yes/no*). "Last night" was defined as the period after taking the previous day's survey (or after 6:00 PM yesterday) until going to sleep. Evening alcohol use was measured each day by summing separate reports of how many drinks students consumed last night in social and nonsocial settings, each using a 17-point scale from 0 to 15+ (recoded as 16). Students were reminded each day that a standard drink was defined as one 12-oz can or bottle of beer or wine cooler, one 5-oz glass of wine, or a 1-oz measure of liquor straight or in a mixed drink.

2.3. Procedure

Data were collected continuously over seven semesters. Approximately 1 month following the start of each semester, students provided informed consent and completed an online baseline survey that included demographics and the COPE inventory. Students began the daily diary study approximately 2–4 weeks after baseline. Students used a secure website to report last night's cannabis and alcohol use each day for 30 days, between the hours of 2:30 – 7:00 PM. This window approximated the time between the end of students' classes and the beginning of their evening activities. If participants missed that day's survey, they could contact the researchers to complete it up to 12:00 PM the next day. To maintain privacy, students were encouraged to complete their surveys alone and to keep their log-in credentials private. At the end of each session, students were also reminded to close their web browser. Students were paid and, when applicable, provided with classroom credit for both the baseline survey and the daily diary study.

2.4. Analysis

To account for nesting of daily data within persons (i.e., non-independence), hypotheses were tested with multilevel modeling using HLM 6.0 (Raudenbush, Bryk, Cheong, & Congdon, 2004). Intraclass correlations for evening alcohol use and cannabis use were calculated from intercept-only models, using a residual variance of 1 for the count model (alcohol) and $\pi^2/3$ for the dichotomous model (cannabis) (Snijders & Bosker, 1999). Models predicting any evening cannabis use were estimated using a Bernoulli distribution for dichotomous outcomes. Evening alcohol use was person-mean centered, and individuals' mean level of evening alcohol use was grand-mean centered and simultaneously entered into the models at the between-person level (Curran & Bauer, 2011). This centering technique partitions variance in the outcome variable into between- and within-person components, allowing one to examine, in this case, whether the likelihood of cannabis use changes based on overall level of drinking and/or daily fluctuations in level of drinking. Gender (0 = *female*, 1 = *male*) and age (centered at 18) were included as between-person covariates, and whether reports of last night's substance use were for a weeknight (0 = Sunday thru Thursday) or a weekend (1 = Friday and Saturday) as a daily-level covariate. Finally, proclivity to cope using alcohol/drugs was grand-mean centered at the between-person level, and we simultaneously tested interactions between coping and evening alcohol use at both the between-person and daily levels.

3. Results

3.1. Descriptive statistics

Students in the final sample used cannabis on an average of 3.2 evenings during the study (*SD* = 5.5, range: 0–29), consumed alcohol on an average of 6.7 evenings (*SD* = 4.3, range: 0–29), and drank an average of 6.3 drinks per episode (*SD* = 3.9, range: 0–32). Furthermore, students used both alcohol and cannabis during the same evening an average of 1.3 times during the study (*SD* = 2.3, range: 0–15). As displayed in Table 1, men were heavier substance users than women across all measures of daily alcohol and cannabis use, and also reported higher proclivity to cope using alcohol/drugs (*p*s   .004).

3.2. Predicting evening cannabis use

The intraclass correlations for evening alcohol use and cannabis use were .52 and .53, respectively, indicating that approximately half of the variance in each behavior was explained at the daily level. Table 2 displays results from models predicting any evening cannabis use. Consistent with the complement hypothesis, both daily and mean levels of evening alcohol use were positively associated with the likelihood of cannabis use. At the within-person level, consuming one more drink on a given evening was associated with 1.07 times higher odds of evening cannabis use. At the between-person level, one more drink consumed during the study month was associated with 1.40 times higher odds of evening cannabis use.

3.3. Moderation by coping with alcohol/drugs

Individuals who reported a stronger proclivity to cope with alcohol/drugs were more likely to engage in evening cannabis use. This relation was qualified, however, by an evening

alcohol use × coping interaction at the daily level of analysis. As displayed in Fig. 1, individuals who reported a weaker tendency to cope using alcohol/drugs showed evidence for the complement hypothesis: a positive relation between evening alcohol consumption and their likelihood of cannabis use (from .034 odds at −2 *SD*s to .095 odds at +2 *SD*s). Individuals with stronger alcohol/drug coping tendencies, however, showed evidence for the substitution hypothesis: a negative relation between evening alcohol use and their likelihood of cannabis use (from .564 odds at −2 *SD*s to .451 odds at +2 *SD*s). The mean evening alcohol use × coping interaction was also significant and of a similar pattern, although less robust than the within-person interaction.[1]

4. Discussion

Understanding whether alcohol and cannabis act as substitutes or complements is necessary for developing policies and interventions to curb substance use. As a novel approach we looked for evidence for these hypotheses using a daily diary survey of substance-using, U.S. college students. Our results generally support earlier findings that college students engage in complementary use of alcohol and cannabis (Williams et al., 2004). Higher overall levels of alcohol consumption, as well as higher consumption on a given evening, predicted higher odds of cannabis use. This finding dovetails with evidence that college students primarily drink and use cannabis for social reasons (Beck et al., 2009; Christiansen et al., 2002; Lee et al., 2007), a motive that could directly lead to students' co-use of these substances, or place students in social situations where both alcohol and cannabis are available (Hall & Lynsky, 2005). This pattern of use may also reflect shared responses within the dopaminergic reward system (Hall & Lynsky, 2005), although we could not assess these mechanisms in the current study.

Students who reported stronger motivation to use alcohol or drugs to cope with stressful events, however, showed a substitute relationship: the more they drank on a given evening, the less likely they were to use cannabis. For these students, using one substance may fulfill their need to alleviate stress, thereby reducing the likelihood that they engage in further substance use during that episode (Stone & Kennedy-Moore, 1992). Although it is problematic to use within-person findings to interpret evidence from more macro-level analyses, these results suggest that samples that vary on key psychosocial factors (e.g., coping strategies) may be one cause of prior discrepancies in the literature (see Crost & Guerrero, 2012). Moreover, these results remind us that even when macro-level analyses reveal a clear pattern of behavior, it remains possible that an important subgroup of people are exhibiting an opposing pattern of behavior.

These findings have important implications for addressing substance use on college campuses, as they suggest that policies or interventions that curb alcohol use might produce different results in different groups of students. For the majority of students who use for social reasons, restricting their alcohol intake may have the welcome benefit of reducing their cannabis use (Williams et al., 2004; cf. White et al., 2015). The overall effectiveness of

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[1]We re-estimated our models using only students who reported evening cannabis use during the diary study (*n* = 482). Results were similar, with the exception that effects for mean evening alcohol use and the mean evening alcohol use × coping interaction were in the same direction but non-significant (*p* = .12 and *p* = .20, respectively).

programs designed to reduce alcohol use, however, may be moderated among students who use to cope, to the degree that limiting their alcohol consumption produces a compensatory increase in cannabis use. Although reducing drinking among these students who are at higher risk of exhibiting substance-related problems (Cooper et al., 1995; Simons et al., 2005) will likely produce a net benefit, more comprehensive strategies that address multiple substances, along with students' underlying motives for substance use, may prove more efficacious for this group.

There are several limitations to this study worth noting. The focus of the larger project was on college student alcohol use, and thus our measures of cannabis use were limited. Future studies would be well-served to measure the degree of students' daily cannabis use, the context of their substance use (e.g., availability, setting, number of social partners), and their motives for using (for a validated scale of cannabis use motives, see Lee, Neighbors, Hendershot, & Grossbard, 2009, or Simons, Correia, Carey, & Borsari, 1998). Likewise, specifying all variables of interest at the within-person level of analysis (i.e., coping motives) may have produced stronger effects that could have shed more light on the underlying processes that lead to either substitution or complementary substance use (cf. O'Hara, Armeli, & Tennen, 2014).

The daily diary design did not allow us to examine the temporal sequencing of students' substance use in a given evening, nor explore whether asymmetries may exist in the relations between alcohol and cannabis use (Petry, 2001). Although prior research suggests that alcohol is typically the precipitating substance during co-use events (Barrett, Darredeau, & Pihl, 2006), fine-grained measurement tools such as ecological momentary assessment (Shiffman, Stone, & Hufford, 2008) would allow researchers to observe how substitute or complementary substance use occurs in close to real-time. For example, mobile technology could allow students to initiate a data collection period whenever they first begin drinking or using cannabis, with automated follow-up surveys that continue to monitor students' substance use throughout the event, thus allowing for temporal sequencing. Moreover, probes about motives for using or not using a substance could help us understand whether and why substitution or complementary use occurs. Finally, our study was conducted at a single university with a primarily European American population, and results may not generalize to other populations of college and non-college young adults. However, rates of cannabis use in our larger sample were comparable to rates reported in larger studies (Caldeira et al., 2008), bolstering our confidence in the external validity of our findings.

5. Conclusion

These findings underscore the need to examine questions, such as the substitute versus complement hypotheses, using varied methodologies in order to fully understand complex behaviors such as substance use. Furthermore, this research highlights the need to consider the motives underlying college students' substance use before proceeding with changes in policy or interventions. Future micro-level studies are needed to explore how individuals use multiple substances in their day-to-day lives, and how patterns of daily use might differ both between and within individuals. This knowledge will help us predict when and for whom we

would expect substitution versus complementary substance use, and ultimately improve our ability to reduce substance use and improve public health.

Acknowledgments

References

Anderson DM, Hansen B, Rees DI. Medical marijuana laws, traffic fatalities, and alcohol consumption. Journal of Law and Economics. 2013; 56:333–369.

Arria AM, Caldeira KM, O'Grady KE, Vincent KB, Fitzelle DB, Johnson EP, Wish ED. Drug exposure opportunities and use patterns among college students: Results of a longitudinal prospective cohort study. Substance Abuse. 2008; 29:19–38.10.1080/08897070802418451 [PubMed: 19042196]

Arria AM, Garnier-Dykstra LM, Caldeira KM, Vincent KB, Winick ER, O'Grady KE. Drug use patterns and continuous enrollment in college : Results from a longitudinal study. Journal of Studies on Alcohol and Drugs. 2013; 74:71–83.10.15288/jsad.2013.74.71 [PubMed: 23200152]

Barrett SP, Darredeau C, Pihl RO. Patterns of simultaneous polysubstance use in drug using university students. Human Psychopharmacology: Clinical and Experimental. 2006; 21:255–263.10.1002/hup. 766 [PubMed: 16783813]

Beck KH, Caldeira KM, Vincent KB, O'Grady KE, Wish ED, Arria AM. The social context of cannabis use: Relationship to cannabis use disorders and depressive symptoms among college students. Addictive Behaviors. 2009; 34:764–768.10.1016/j.addbeh.2009.05.001 [PubMed: 19497678]

Bergamaschi MM, Queiroz RHC, Chagas MHN, de Oliveira DCG, Martinis BSD, Kapczinski F, … Crippa JAS. Cannabidiol reduces the anxiety induced by simulated public speaking in treatment-naïve social phobia patients. Neuropsychopharmacology. 2011; 36:1219–1226.10.1038/npp.2011.6 [PubMed: 21307846]

Bowles, P. Their Heads are Green and Their Hands are Blue: Scenes from the Non-Christian World. HarperCollins Pub; 2006.

Brodbeck J, Matter M, Page J, Moggi F. Motives for cannabis use as a moderator variable of distress among young adults. Addictive Behaviors. 2007; 32:1537–1545.10.1016/j.addbeh.2006.11.012 [PubMed: 17178197]

Caldeira KM, Arria AM, O'Grady KE, Vincent KB, Wish ED. The occurrence of cannabis use disorders and other cannabis-related problems among first-year college students. Addictive Behaviors. 2008; 33:397–411.10.1016/j.addbeh.2007.10.001 [PubMed: 18031940]

Cameron L, Williams J. Cannabis, alcohol, and cigarettes: Substitutes or complements? The Economic Record. 2001; 77:19–34.

Carver CS, Scheier MF, Weintraub JK. Assessing coping strategies: A theoretically based approach. Journal of Personality and Social Psychology. 1989; 56:267–283.10.1037/0022-3514.56.2.267 [PubMed: 2926629]

Christiansen M, Vik PW, Jarchow A. College student heavy drinking in social contexts versus alone. Addictive Behaviors. 2002; 27:393–404. [PubMed: 12118627]

Crost B, Guerrero S. The effect of alcohol availability on marijuana use: Evidence from the minimum legal drinking age. Journal of Health Economics. 2012; 31:112–121. [PubMed: 22381404]

Crippa JA, Derenusson GN, Ferrari TB, Wichert-Ana L, Duran FLS, Martin-Santos R, … Hallak JEC. Neural basis of anxiolytic effects of cannabidiol (CBD) in generalized social anxiety disorder: A preliminary report. Journal of Psychopharmacology. 2011; 25:121–130. [PubMed: 20829306]

Curran PJ, Bauer DJ. The disaggregation of within-person and between-person effects in longitudinal models of change. Annual Review of Psychology. 2011; 62:583–619.10.1146/annurev.psych. 093008.100356

DiNardo J, Lemieux T. Alcohol, marijuana, and American youth: The unintended consequences of government regulation. Journal of Health Economics. 2001; 20:991–1010. [PubMed: 11758056]

Dogg, SD. Gin and Juice. Death Row/Interscope; 1994.

Farrelly, MC.; Bray, JW.; Zarkin, GA.; Wendling, BW.; Pacula, RL. The effects of prices and policies on the demand for marijuana: Evidence from the National Household Surveys on Drug Abuse (No. w6940). National Bureau of Economic Research; 1999.

Greeley, J.; Oei, T. Alcohol and tension reduction. In: Leonard, KE.; Blane, HT., editors. Psychological Theories of Drinking and Alcoholism. 2. New York: Guilford Press; 1999. p. 14-53.

Gunthert, KC.; Wenze, SJ. Daily diary methods. In: Mehl, MR.; Conner, TS., editors. Handbook of research methods for studying daily life. New York: Guilford Press; 2012. p. 144-159.

Hall WD, Lynsky M. Is cannabis a gateway drug? Testing hypotheses about the relationship between cannabis use and the use of other illicit drugs. Drug and Alcohol Review. 2005; 24:39–48.10.1080/09595230500126698 [PubMed: 16191720]

Khantzian EJ. The self-medication hypothesis of substance use disorders: A reconsideration and recent applications. Harvard Review of Psychiatry. 1997; 4:231–244. [PubMed: 9385000]

Knight JR, Wechsler H, Kuo M, Seibring M, Weitzman ER, Schuckit MA. Alcohol abuse and dependence among U.S. college students. Journal of Studies on Alcohol. 2002; 63:263–270. [PubMed: 12086126]

Krauss MJ, Cavazos-Rehg PA, Agrawal A, Bierut LJ, Grucza RA. Long-term effects of minimum legal drinking age laws on marijuana and other illicit drug use in adulthood. Drug and Alcohol Dependence. 2015; 149:173–179. [PubMed: 25707705]

Lee CM, Neighbors C, Woods BA. Marijuana motives: Young adults' reasons for using marijuana. Addictive Behaviors. 2007; 32:1384–1394. [PubMed: 17097817]

Lee CM, Neighbors C, Hendershot CS, Grossbard JR. Development and preliminary validation of a comprehensive marijuana motives questionnaire. Journal of Studies on Alcohol and Drugs. 2009; 70:279–287. [PubMed: 19261240]

Merrill JE, Read JP. Motivational pathways to unique types of alcohol consequences. Psychology of Addictive Behaviors. 2010; 24:705–711. [PubMed: 20822194]

O'Hara RE, Armeli S, Tennen H. College students' drinking motives and social-contextual factors: Comparing associations across levels of analysis. Psychology of Addictive Behaviors. 2014; 29:420–429. [PubMed: 25546143]

Pacula RL. Does increasing the beer tax reduce marijuana consumption? Journal of Health Economics. 1998; 17:557–585. [PubMed: 10185512]

Park CL, Levenson MR. Drinking to cope among college students: Prevalence, problems, and coping processes. Journal of Studies on Alcohol. 2002; 63:486–497. [PubMed: 12160108]

Petry NM. A behavioral economic analysis of polydrug use in alcoholics: Asymmetrical substitution of alcohol and cocaine. Drug & Alcohol Dependence. 2001; 62:31–39. [PubMed: 11173165]

Raudenbush, SW.; Bryk, AS.; Cheong, YF.; Congdon, RT. HLM 6: Hierarchical linear and nonlinear modeling [Computer software manual]. Chicago, IL: Scientific Software International; 2004.

Saffer H, Chaloupka F. The demand for illicit drugs. Economic Inquiry. 1999; 37:401–411.

Sher KJ, Bartholow BD, Peuser K, Erickson DJ, Wood MD. Stress-response-dampening effects of alcohol: Attention as a mediator and moderator. Journal of Abnormal Psychology. 2007; 116:362–377. [PubMed: 17516768]

Shiffman S, Stone AS, Hufford MR. Ecological momentary assessment. Annual Review of Clinical Psychology. 2008; 4:1–32.

Shillington AM, Clapp JD. Heavy alcohol use compared to alcohol and marijuana use: Do college students experience a difference in substance use problems? Journal of Drug Education. 2006; 36:91–103.10.2190/8PRJ-P8AJ-MXU3-H1MW [PubMed: 16981642]

Simons J, Correia CJ, Carey KB. A comparison of motives for marijuana and alcohol use among experienced users. Addictive Behaviors. 2000; 25:153–160. [PubMed: 10708331]

Simons JS, Correia CJ, Carey KB, Borsari BE. Validating a five-factor marijuana motives measure: Relations with use, problems, and alcohol motives. Journal of Counseling Psychology. 1998; 45:265–273.

Simons JS, Gaher RM, Correia CJ, Hansen CL, Christopher MS. An affective-motivational model of marijuana and alcohol problems among college students. Psychology of Addictive Behaviors. 2005; 19:326–334.10.1037/0893-164X.19.3.326 [PubMed: 16187813]

Snijders, T.; Bosker, R. Multilevel analysis. London: Sage Publications; 1999.

Stone, AA.; Kennedy-Moore, E. Commentary to part three: Assessing situational coping: Conceptual and methodological considerations. In: Friedman, HS., editor. Hostility, coping, and health. Washington, DC: American Psychological Association; 1992. p. 203-214.

Vitale SA. "Dope" dilemmas in a budding future industry: An examination of the current status of marijuana legalization in the United States. University of Miami Business Law Review. 2014; 23:131–176.

Wechsler H, Lee JE, Kuo M, Seibring M, Nelson TF, Lee H. Trends in college binge drinking during a period of increased prevention efforts. Journal of American College Health. 2002; 50:203–217. [PubMed: 11990979]

White HR, Jiao Y, Ray AE, Huh D, Atkins DC, Larimer ME, … Mun E-Y. Are there secondary effects on marijuana use from brief alcohol interventions for college students? Journal of Studies on Alcohol and Drugs. 2015; 76:367–377. [PubMed: 25978822]

Williams J, Mahmoudi P. Economic relationship between alcohol and cannabis revisited. The Economic Record. 2004; 80:36–48.

Williams J, Pacula RL, Chaloupka FJ, Wechsler H. Alcohol and marijuana use among college students: economic complements or substitutes? Health Economics. 2004; 13:825–843. [PubMed: 15362176]

Highlights

- College students reported alcohol and cannabis co-use approximately once per month.

- Students who were less likely to use drugs to cope showed complementary drug use.

- Students who were more likely to use drugs to cope showed drug substitution.

- The substitute vs. complement debate may be resolved by individual differences.
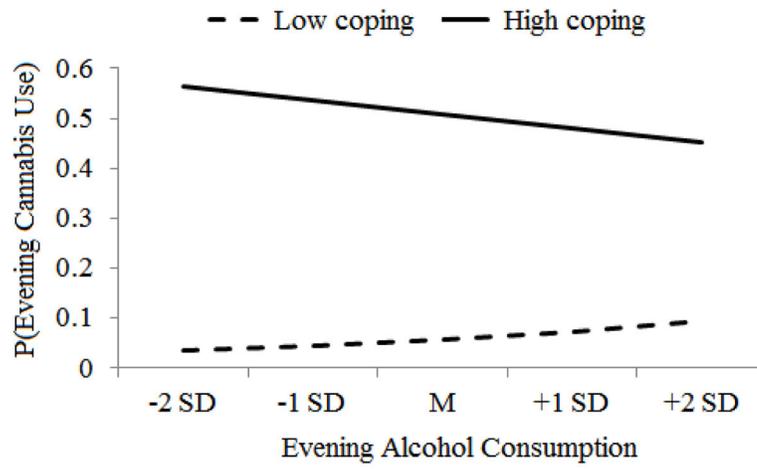
Figure 1.
Evening alcohol consumption × coping with alcohol/drugs interaction predicting the probability of evening cannabis use. Low Coping: −2 *SD*s; High Coping: +2 *SD*s.

Table 1

Descriptive Statistics for Primary Variables by Gender

	Men (*n* = 444)	Women (*n* = 432)	*p*-value
	M (*SD*)	*M* (*SD*)	
Number of drinking evenings[1]	7.44 (4.70)	6.03 (3.70)	< .001
Number of drinks per drinking evening[2]	7.52 (3.89)	5.14 (2.24)	< .001
Number of evenings with any cannabis use[1]	4.59 (6.67)	1.69 (3.47)	< .001
Number of evenings with any cannabis and alcohol co-use[1]	1.74 (2.73)	0.75 (1.50)	< .001
Coping with alcohol/drugs[3]	5.36 (2.58)	4.88 (2.30)	.004

Note. SD = standard deviation.

[1] range: 0–29;

[2] range: 0–32;

[3] range: 0–12.

Table 2

Multilevel Model Results Predicting Any Evening Cannabis Use[1]

	Adjusted Odds Ratio	95% CI	*p*-value
Daily-level Predictors			
Evening alcohol use[2]	1.07	1.05, 1.08	< .001
Weekend[3]	2.13	1.87, 2.41	< .001
Between-person predictors			
Mean evening alcohol use[4]	1.40	1.27, 1.55	< .001
Coping with alcohol/drugs[4]	1.36	1.28, 1.44	< .001
Gender[5]	2.43	1.98, 3.68	< .001
Age[6]	0.96	0.85, 1.08	.484
Interactions			
Mean evening alcohol use × coping	0.88	0.79, 0.99	.028
Evening alcohol use × coping	0.99	0.98, 0.99	< .001

Note. CI = confidence interval.

[1] 0 = no use, 1 = use;

[2] person mean-centered;

[3] 0 = weeknight, 1 = weekend (Friday or Saturday);

[4] grand mean centered;

[5] 0 = female, 1 = male;

[6] centered at 18.