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Simultaneous Alcohol and Cannabis Use in College Students: Examining Context, Route of Administration, Cognitive Factors, and Consequences via Daily Diary

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SIMULTANEOUS ALCOHOL AND CANNABIS USE IN COLLEGE STUDENTS: EXAMINING CONTEXT, ROUTE OF ADMINISTRATION, COGNITIVE FACTORS, AND CONSEQUENCES VIA DAILY DIARY

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ABSTRACT

SIMULTANEOUS ALCOHOL AND CANNABIS USE IN COLLEGE STUDENTS: EXAMINING CONTEXT, ROUTE OF ADMINISTRATION, COGNITIVE FACTORS, AND CONSEQUENCES VIA DAILY DIARY

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Cannabis and alcohol use are pervasive among college students. Simultaneous alcohol and cannabis (commonly referred to as simultaneous alcohol and marijuana [SAM]) use (i.e., effects overlap) is more prevalent than concurrent alcohol and cannabis (commonly referred to as concurrent alcohol and marijuana [CAM]) use (i.e., effects do not overlap). Consequences of SAM use are often greater than CAM or single substance use. Research has explored cognitions (motives, expectancies) and contexts (environmental, social) as predictors of SAM use among adolescents, young adults, and adults; however, research is needed among college students specifically. Limited research has examined type of alcohol and route of cannabis administration for separate use, but not CAM or SAM use. The current study, a 21-day daily diary among college students, addressed these gaps via three aims. Aim 1 identified the most common type of alcohol was consuming multiple types of alcohol and the most common route of cannabis administration was plant. Additionally, there was an association between quantity of alcohol consumed, such that more alcohol was consumed on days when shots (liquor) or caffeinated mixed drinks were consumed. There was not an association between route of cannabis administration and quantity consumed. Aim 2 examined if consequences, cognitions, contexts, and quantity of alcohol and cannabis used varies across SAM versus CAM days. Results showed

that participants reported fewer consequences on CAM versus SAM use days. Aim 3 examined if SAM-specific consequences, cognitions, and contexts vary across type of alcohol and route of cannabis administration and found that on SAM use days when shots (liquor) are consumed, compared to multiple types of alcohol, participants reported experiencing more SAM expectancies. However, all results should be interpreted with caution due to the low sample size, possibly increasing Type II error. In addition, the small sample precluded the examination of some study aims, such as if there is an association between type of alcohol/route of cannabis administration and type of day (SAM, CAM, or separate use; part of Aim 1). In conclusion, the current study replicated and expanded the research on co-use of alcohol and cannabis in a college student sample.

This thesis is dedicated to my parents and sister for their unconditional love and support.

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CHAPTER I

INTRODUCTION

State laws regarding recreational cannabis use have been changing over the last decade, with 11 states and the District of Colombia legalizing recreational cannabis use for adults, in small amounts (National Conference of State Legislatures, 2019). In 2018, the annual prevalence of cannabis use in college students was 42% and the annual prevalence of alcohol use in college students was 75% (Schulenberg et al., 2019). Prevalence of cannabis use and alcohol use in the prior 30 days was 25% and 60%, respectively (Schulenberg et al., 2019). Legalization of recreational use of cannabis has impacted the odds of using cannabis in college students who attend colleges in these states (Bae & Kerr, 2019). Bae and Kerr (2019) examined data from the National College Health Assessment between the years of 2008-2019. During this time, seven states in the study legalized recreational use of cannabis whereas the other 41 states did not. For college students who attended college in a state with legalized recreational cannabis use, the odds of using cannabis increased by 23% compared to those that attended college in a state that had not legalized recreational cannabis (Bae & Kerr, 2019).

Alcohol and cannabis use in college students is not only prevalent, but also problematic. Academic problems related to alcohol and cannabis use include getting behind in schoolwork, lower grades, and a decline in GPA (Arria et al., 2015; Martinez et al., 2014). Other problems related to alcohol and cannabis use include blacking out, injury, and property damage (Pearson et al., 2017; White & Hingson, 2013). Due to the high prevalence and increasing odds of alcohol and cannabis use, and their related problems, it is important to examine what can predict use (i.e., risk factors). There is a well-established literature demonstrating how different cognitive factors predict alcohol use and related consequences. For example, specific alcohol-related

motives and expectancies have been found to lead to increased alcohol consumption and related consequences (e.g., Cook et al., 2019; Jones et al., 2001). The literature regarding how different cognitive factors predict cannabis use and related consequences is relatively newer. Similar to alcohol, cannabis-related motives and expectancies have been found to predict cannabis use and related consequences (e.g., Lee et al., 2009; Patrick, Bray, & Berglund., 2016). Alcohol and cannabis can be used on their own, but many individuals also use them concurrently and/or simultaneously. Concurrent alcohol and cannabis (commonly referred to as concurrent alcohol and marijuana [CAM]) use is defined as using both substances, but not at the same time to where their effects overlap, whereas simultaneous alcohol and cannabis (commonly referred to as simultaneous alcohol and marijuana [SAM]) use is defined as using both substances so that their effects do overlap (Earleywine & Newcomb, 1997). There is an emerging literature regarding co-use of alcohol and cannabis, whether simultaneously or concurrently. Among the general population, prevalence of SAM use was almost double the prevalence of CAM use for those that consumed both alcohol and cannabis in the past year. Out of the 11.4% of participants who consumed alcohol and used cannabis, the majority (7.5%) reported SAM use as opposed to CAM use (3.9%; Subbaraman & Kerr, 2015). Furthermore, Terry-McElrath and Patrick (2018) reported that a third of young adults who use alcohol also reported simultaneous use with cannabis. More specifically, Bravo et al. (in press) reported that among college students in the U.S. (from five universities across four states) who use both substances, 74% reported SAM use and 26% reported only CAM use. The recent literature regarding SAM use shows that it is prevalent and problematic, and more research is needed to understand the risk factors of use.

As more states pass legislation to legalize recreational cannabis, it is imperative that further research is conducted in the college student population to better understand the risk

factors for single substance, CAM, and SAM use, including consequences, motives, expectancies, and context of use. Conducting research among the college student population allows researchers to reach a representative sample of the U.S. population (Lederer & Oswalt, 2017). It is also important to study alcohol and cannabis use in college students specifically, rather than the young adult population in general, as research has demonstrated that there are differences in substance use patterns between college students and non-college-attending young adults (Patrick, Yeomans-Maldonado, & Griffin, 2016). Moreover, because cannabis use is illegal at the federal level, as cannabis is classified as a Schedule I drug, college students cannot use cannabis without repercussions, such as loss of federal financial aid (Johnson, n.d.; United States Drug Enforcement Agency, n.d.). Differentiating the risk factors (e.g., cognitions, context) across types of use (i.e., single substance, CAM, or SAM use) would allow public health leaders to develop targeted campaigns.

Furthermore, various types of alcohol are available for consumption, and routes of cannabis administration are growing in availability. As dispensaries began to open when medical cannabis was legalized, more routes of cannabis administration were created and made available for consumers (Ghosh et al., 2015). Research is needed to determine the most common types of alcohol and routes of cannabis administration, both when used own their own and when used simultaneously, examine if there is any variation across type of use (i.e., single substance, CAM use, SAM use), as well as if risk factors (i.e., consequences, cognitions, context) vary across type of alcohol and route of cannabis administration.

Single Substance Use

Alcohol Consequences, Motives, Expectancies, and Contexts

Consequences. College drinking can cause many different harms, such as injury, property damage, assaults, and even death (White & Hingson, 2013). It is estimated that in one year, 1,519 college students died from alcohol-related unintentional injuries, including car crashes and nontraffic injuries, and 97,000 were survivors of sexual assault or date rape (Hingson et al., 2009, 2014). There are well known consequences linked with college drinking (for a review, see Mallet et al., 2013). For example, Barnett et al. (2014) examined the associations between alcohol use and consequences in first year college students across three colleges throughout the course of a year and found that alcohol consumption (i.e., drinks per drinking day) were associated with both positive and negative consequences, after controlling for time of year and demographics. In other words, greater alcohol consumption, such as more drinks per drinking day, were related to reporting more consequences experienced, both positive and negative (Barnett et al., 2014). Patrick, Cronce, et al. (2016) utilized a longitudinal daily diary methodology to examine high-intensity drinking (i.e., 8+ drinks for women and 10+ drinks for men) in freshman, sophomores, and juniors and found that when students were participating in high-intensity drinking, they reported both more positive and negative consequences than non-high-intensity drinking days. These results were confirmed by Mallett et al. (2019); they examined substance use and related consequences in third year college students across 18 weekend days (i.e., Thursday-Saturday across six weeks) and found that heavy drinking alcohol use occasions (i.e., 4+/5+ drinks for women/men) were associated with more consequences than lighter alcohol use occasions (i.e., fewer drinks than 4+/5+; Mallett et al., 2019). It is well established that greater levels of alcohol consumption are robustly associated with both positive and negative consequences.

Motives. Drinking motives, or reasons for consuming alcohol, have been found to uniquely predict alcohol use and related consequences cross-sectionally, longitudinally, and at the daily level; four motives have been identified: social (e.g., “As a way to celebrate”), coping (e.g., “To forget your worries”), enhancement (e.g., “Because it’s exciting”), and conformity (e.g., “To be liked”; Cooper, 1994). In a study of undergraduate college student drinkers, it was found that stronger social motives were associated with greater alcohol use (Skalisky et al., 2019). Using a daily diary methodology, Patrick et al. (2019) found that there was a positive association between daily social and enhancement motives and same day alcohol use in young adults. Not only are motives associated with increased alcohol use (both globally and on a daily level), they are also associated with high risk alcohol use. In a study that examined a large sample of college student drinkers, high intensity drinkers (more than 8 standard drinks for women, more than 10 standard drinks for men) endorsed more coping, social, and enhancement motives than those who did not meet these high intensity drinking criteria (White et al., 2016). Drinking motives can also predict negative alcohol-related consequences (Merrill et al., 2014). A longitudinal study of college students found that coping motives directly predicted select alcohol-related consequences after controlling for consumption level, and enhancement motives indirectly predicted consequences through higher levels of alcohol consumption (Merrill et al., 2014). Research regarding alcohol-related motives is well established and provides a strong foundation for understanding the relationship between drinking motives and alcohol use and related consequences.

Expectancies. As with alcohol motives, alcohol expectancies, or what an individual expects to happen if they consume alcohol, are also associated with different levels of alcohol consumption and related consequences; the Alcohol Expectancy Questionnaire (AEQ; Brown et

al., 1980; Brown et al., 1987) identifies six expectancies: global, positive change (e.g., “If I am feeling restricted in any way, a few drinks makes me feel better”); enhanced sexual (e.g., “I feel more masculine/feminine after a few drinks”); physical and social assertiveness (e.g., “Drinking adds a certain warmth to social occasions”); increased social assertiveness (e.g., “When I am drinking, it is easier to open up and express my feelings”); relaxation and tension reduction (e.g., “If I am tense or anxious, having a few drinks makes me feel better”); and arousal and power (e.g., “A couple of drinks makes me more aroused or physiologically excited”; Brown et al., 1980; Brown et al., 1987). Individual expectancies have also been categorized as positive (e.g., sociability) and negative expectancies (e.g., cognitive and behavioral impairment) Comprehensive Effects of Alcohol [CEOA]; Fromme et al., 1993). Prior research has demonstrated associations between alcohol expectancies and both alcohol consumption and related problems. Lewis and O’Neill (2000) found that undergraduate students who were classified as problem drinkers (based on their scores from the Rutgers Collegiate Substance Abuse Screening Test; Bennett et al., 1993) endorsed more positive alcohol expectancies than did nonproblem drinkers. From a daily diary perspective, expectancies were found to change within an individual from day to day (Ramirez et al., 2020). In a sample of college students (freshmen, sophomores, and juniors), Ramirez et al. (2020) used Interactive Voice Response to collect data three times daily over four two-week periods and found that an individual was more likely to consume a greater amount of alcohol on drinking days in which they reported stronger positive expectancies. The same was true for negative expectancies. Additionally, expectancies have been found to predict specific alcohol-related consequences. In a sample of college students who reported consuming alcohol in the past month, Park and Grant (2005) found that positive expectancies were related to more consequences (positive and negative), controlling for alcohol

consumption. Lee, Fairlie, et al. (2020) examined alcohol expectancies and consequences in college student drinkers (freshman-junior standing) using a daily diary longitudinal measurement burst design, specifically over four 2-week periods. They found that greater specific positive expectancies (e.g., being more social) were associated with experiencing positive consequences the next day, controlling for alcohol consumption on that day. The same was true for specific negative expectancies and negative consequences, suggesting that a self-fulfilling prophecy effect is taking place in college student drinkers, such that when college student drinkers expect certain alcohol-related effects, they experience those effect-related consequences later that day, even after controlling for alcohol consumption (Lee, Fairlie, et al., 2020). Research has provided strong evidence of the relationship between alcohol expectancies and use both globally and daily, as well as their associations with consequences.

Contexts. In addition to cognitive factors identified as risk factors for elevated alcohol use and related consequences, prior research has also found that environmental and social contexts are related to different drinking behaviors (for a review, see Mair et al., 2019). College drinkers across 14 institutions in California participated in a large experimental study; all institutions were part of the environmental intervention (e.g., DUI checkpoints, ordinances), and students reported their drinking after these changes, including their drinking locations during the past semester (Marzell et al., 2015). Results indicate that attending a party in one of four different settings (a Greek house, on-campus residence hall, off-campus residence, or on-campus event) was associated with greater alcohol consumption (Marzell et al., 2015). In a retrospective design, consuming alcohol at a bar or party was found to be associated with greater same-day alcohol consumption among college students, after controlling for protective behavioral strategies use (Braitman et al., 2017). In a study of 21st birthday drinking among college student,

Rodriguez et al. (2016) found that celebrating a 21st birthday in a bar or at a Greek house was linked to greater number of drinks and estimated blood alcohol content (eBAC) compared to other locations. Context is also important for specific alcoholic beverages, and how this can relate to craving (e.g., Stamates & Lau-Barraco, 2017). Among college student caffeinated alcohol beverage users, it was found that subjective craving for caffeinated alcohol beverages was greater in a simulated bar setting than a neutral condition (Stamates & Lau-Barraco, 2017).

In addition to environmental contexts, select social contexts can serve as a risk factor for drinking. Among adolescents who participated in an ecological momentary assessment study, a positive association was found between the number of people at a location and risk of alcohol use, such that more people present were linked to greater likelihood of a participant drinking at that location (Lipperman-Kreda et al., 2017). This finding aligns with qualitative findings; adolescents in California indicated via in-person and phone interviews that they are most likely to choose to use alcohol in party settings, specifically with many people, but no adults, present (Price Wolf et al., 2019). Among a college student sample, Clapp et al. (2006) utilized surveys conducted over the telephone and found that being with numerous intoxicated people, either at a private party or at a bar/club, was associated with greater alcohol consumption. Not only are people more likely to drink with others present, they are more likely to drink with specific people. After controlling for protective behavioral strategies, Braitman et al. (2017) found that drinking with friends was linked with consuming more drinks. In contrast, drinking with family or by themselves was linked with consuming less drinks. Additionally, Rodriguez et al. (2016) found that lighter drinking was associated with participants celebrating their 21st birthday with a romantic partner and heavier drinking was associated with celebrating with Greek-life members, friends, acquaintances, and roommates. Although drinking with others (or specific others) is

related to more alcohol consumption overall, research has found differences in negative consequences between those who drink alone and those who drink with others. Christiansen et al. (2002) examined the differences in reporting negative alcohol-related consequences among three different groups from a sample of college students: those who drank heavily in social contexts, those who drank heavily by themselves, and those who did not drink heavily. They found that those who drank heavily by themselves reported experiencing more negative alcohol-related consequences than the other two groups (Christiansen et al., 2002). Environmental and social contexts are important risk factors to examine in relation to alcohol use.

Types of Alcohol

Along with cognitive factors and contexts, different types of alcoholic drinks consumed may be risk factors for negative alcohol-related consequences experienced (e.g., Baltieri et al., 2009; Linden-Carmichael & Lau-Barraco, 2017; Mochrie et al., 2019). For example, Baltieri et al. (2009) found that among alcohol-dependent male adults who were seeking outpatient treatment, those who chose spirits as their drink of choice had more consequences, such as more severe alcohol dependency and craving, and a more frequent history of alcohol treatment compared to those who chose beer as their drink of choice. Utilizing a daily diary methodology over 14 consecutive days, Linden-Carmichael and Lau-Barraco (2017) found that among heavy drinking college students who used caffeinated alcoholic beverages, more alcohol-related consequences were reported on days in which they drank caffeinated alcoholic beverages compared to other types of alcohol (Linden-Carmichael & Lau-Barraco, 2017). Among college freshman and sophomores who were participants in a larger college student health survey, more negative consequences were reported among those who preferred consuming shots or mixed drinks compared to those who preferred beer (Mochrie et al., 2019). In addition to associations

with alcohol use and related consequences, choice of alcohol type has been linked to reasons for drinking and alcohol-focused expectancies (e.g., Callinan & MacLean, 2016; Pederson et al., 2010). Among young adult Australians, qualitative interviews with researchers revealed shots were the drink of choice when the intent was to be intoxicated (Callinan & MacLean, 2016). In addition, Pedersen et al. (2010) examined if college students' alcohol-focused expectancies varied by type of beverage, randomizing participants to answer expectancy questions about either beer, wine, or shots of distilled spirits (including mixed drinks). Students expected wine to have an effect of relaxation more so than shots of distilled spirits, and they expected wine to have a stronger positive effect on sexuality than beer or spirits, and weaker impairment effect than beer or spirits (Pedersen et al., 2010). Future research needs to continue to examine the relationship between types of alcohol and their impact on alcohol use and their related consequences; to date, no one has examined their intersection with cannabis use.

Cannabis Consequences, Motives, Expectancies, and Contexts

Consequences. As with alcohol use, cannabis use can result in a variety of negative consequences (e.g., Arria et al., 2015; Pearson et al., 2017). In a sample of college students from 11 universities across multiple states, Pearson et al. (2017) examined consequences due to cannabis use in the past month reported by participants. Close to 50% of past-month cannabis users reported driving a car while under the influence of cannabis. Other consequences that were endorsed by over 40% of cannabis-using participants were participating in embarrassing behaviors, using cannabis when they were not planning to, and "feeling in a fog, sluggish, tired, or dazed the morning after use" (Pearson et al., 2017, p. 87). In contrast, the consequences that were least commonly reported by past-month cannabis users included property damage or some other type of disruption and physical harms, such as "injuring someone else, getting into physical

fights, and having unprotected sex" (Pearson et al., 2017, p. 87). Arria et al. (2015) focused specifically on academic consequences related to using cannabis, finding that college students who used cannabis reported negative academic outcomes, such as lower grades due to skipping more classes. Arria et al. (2015) also found that there was an inverse prospective relationship between cannabis use GPA, such that those that increased their cannabis use over their years in college saw a decline in GPA. Cannabis use among college students is clearly related to various negative consequences, including academic (e.g., GPA), interpersonal (e.g., embarrassing behavior), personal (e.g., feeling sluggish/tired/dazed), and harm to self and others (e.g., driving under the influence).

Motives. Similar to alcohol use, motives and expectancies related to cannabis use are associated with actual use and related consequences. The Comprehensive Marijuana Motive Questionnaire (Lee et al., 2009) identifies 12 motives: enjoyment (e.g., "Because it is fun"); conformity (e.g., "To be cool"); coping (e.g., "To escape from your life"); experimentation (e.g., "To see what it felt like"); boredom (e.g., "To relieve boredom"); alcohol (e.g., "Because you were under the influence of alcohol"); celebration (e.g., "Because it was a special day"); altered perceptions (e.g., "To allow you to think differently"); social anxiety (e.g., "To make you feel more confident"); relative low risk (e.g., "Because it is not a dangerous drug"); sleep (e.g., "Because it helps make napping easier and enjoyable"); and availability (e.g., "Because you can get it for free"). Another measure of cannabis motives, the Marijuana Motives Measure (Simons et al., 1998) was modeled after Cooper's (1994) Drinking Motives Measure, and identifies five motives: conformity (e.g., "I use marijuana so that others won't kid me about not using marijuana"); expansion (e.g., "I use marijuana so that I can know myself better"); coping (e.g., "I use marijuana to forget my worries"); social (e.g., "I use marijuana to be sociable"); and

enhancement (e.g., “I use marijuana to get high”). Lee et al. (2007) qualitatively assessed marijuana use motives in young adult incoming students to a large public university, asking open ended questions regarding marijuana motives. They found that the most frequently reported reason for use was for enjoyment/fun, which also predicted heavier cannabis use. Among a sample of young adult past-month SAM users who completed twice-daily assessments over 14 days, there was a positive association between enhancement cannabis motives and number of hours feeling the effects of cannabis, specifically feeling high (Patrick et al., 2019). Cannabis use motives have been found to be associated with other cannabis use outcomes. Buckner et al. (2015) conducted an ecological momentary assessment study among a sample of current cannabis users, with the majority meeting criteria for a cannabis use disorder, and found that there was a positive association between cannabis use withdrawal symptoms and coping motives during cannabis use episodes, such that when withdrawal symptoms were greater, coping motives were the most endorsed reason for using cannabis. Coping and social motives were also associated with negative affect (Buckner et al., 2015). Lastly, Simons et al. (1998) found that among cannabis-using college students, enhancement, coping, social, and expansion motives were significantly correlated with both cannabis use and related problems, such that higher motives for use were associated with greater use and more cannabis problems. It is important to understand why college students use cannabis and how it impacts cannabis use outcomes.

Expectancies. As with motives, expectancies of using cannabis have been linked to cannabis use and problems; six expectancies have been identified: cognitive and behavioral impairment (e.g., “Marijuana slows thinking and actions”); relaxation and tension reduction (e.g., “Marijuana makes me calm”); social and sexual facilitation (e.g., “Marijuana makes me talk more than usual”); perceptual and cognitive enhancement (e.g., “I become more creative or

imaginative on marijuana"); global negative effects (e.g., "After the "high" of smoking marijuana, I feel down"); and craving and physical effects (e.g., "Smoking marijuana makes me hungry"; Schafer & Brown, 1991). In a sample of college students who used cannabis, expectancies related to cannabis use effects were found to significantly relate to use intensity, specifically that positive expectancies, such as relaxation and tension reduction, had a positive association with use intensity and negative expectancies, such as global negative effects, had a negative association with use intensity (Gaher & Simmons, 2007). Similar results were found in another sample of college students who reported using cannabis, such that positive expectancies had a positive relationship with cannabis use frequency (i.e., stronger positive expectancies were associated with more frequent use) and negative expectancies had a negative relationship with cannabis use frequency (i.e., stronger negative expectancies were associated with less frequent use; Buckner, 2013). Hayaki et al. (2010) found that more specifically, the expectancy of using to relax or reduce tension had a positive relationship with frequency of cannabis use among emerging adult women who used cannabis at least monthly in the last three months. Hayaki et al. (2010) also found that all cannabis use expectancies assessed (cognitive and behavioral impairment, relaxation and tension reduction, social and sexual facilitation, perceptual and cognitive enhancement, global negative effects, and craving and physical effects) had a positive relationship with severity of cannabis use, meaning stronger expectancies were associated with more symptoms of cannabis abuse and dependence; the strongest correlation was with the expectancy of using cannabis to relax or reduce tension. Taken together, reasons for using cannabis are consistently associated with cannabis use intensity and severity.

Contexts. Similar to alcohol use, level of cannabis use varies across environmental and social contexts. Using *Monitoring the Future* data, it was found that adolescents tend to use

cannabis more often at parties and with others present (McCabe et al., 2014). Further emphasizing this finding, an ecological momentary assessment study with college students found that students tend to use cannabis with others present rather than alone (Phillips et al., 2018). Among a sample of adolescent cannabis users who were part of a larger longitudinal study, those who used cannabis by themselves met more criteria for DSM-IV cannabis use disorder than those who used cannabis in social settings (Creswell et al., 2015). Environmental and social contexts are important predictors of cannabis use and related problems; however, the way in which context intersects with co-use of alcohol and cannabis has not yet been explored in college students specifically. In addition, type of alcohol and route of cannabis administration during co-use has not been examined across contexts of use.

Routes of Cannabis Administration

As mentioned previously, with the expansion of dispensaries in states with legal cannabis use laws, more routes of administration of cannabis are now available (Ghosh et al., 2015). In recent studies, the most common route of cannabis administration in young adults and adults was smoking (Reboussin et al., 2019; Steigerwald et al., 2018). A large study of post-college young adults found that among current cannabis users, smoking was the most common route of administration (Reboussin et al., 2019). In a large, nationally representative sample of U.S. adults using KnowledgePanel, Steigerwald et al. (2018) also found smoking to be the most common route of administration. However, other routes of administration include edibles, dabbing (“inhalation of concentrated butane-extracted cannabis products”), and vaping (“vaporizing cannabis products to create an aerosolized mixture of water and active ingredients, which is inhaled”; Choo & Emery, 2017, p. 63). Edibles (e.g., brownies) and concentrates (e.g., dabbing) tend to have higher potency than other routes of administration, which is cause for

concern in terms of risks associated with these routes (Prince & Conner, 2019; Steigerwald et al., 2018). In terms of environmental context of use, recent research found that bachelor's and master's college student past-month cannabis users tend to most frequently be in a private residence when using any form of cannabis; however, they choose vaping or edibles in locations where discretion is needed (Jones et al., 2018), suggesting that context could influence the choice to use higher risk routes of administration. Most research has not examined how, or if, route of administration is associated with motives and expectancies.

Measurement of Type of Alcohol/Route of Cannabis Administration

To understand the literature, it is important to review how alcohol consumption is measured. Alcohol consumption tends to be measured using approaches that measure quantity (i.e., number of drinks consumed in a specified timeframe, such as one drinking session or day), frequency (i.e., how often, such as number of days, an individual drinks), and/or graduated frequency (i.e., frequency of consuming a specific number of drinks, such as binge drinking; Dawson, 2013). To be able to accurately assess quantity, standard drink sizes are defined and utilized (i.e., 12 fluid oz. of beer = 4-5 fluid oz. of wine; National Institute on Alcohol Abuse and Alcoholism [NIAAA], n.d.). This allows researchers to be able to collect data knowing that no matter the type of beverage, quantity can be accurately measured because a standard drink contains the same amount of ethanol. However, if specific beverage type is warranted for research questions under examination, then questions have historically related to three categories of alcoholic beverages: beer, wine, and distilled spirits (Dawson, 2013). Sometimes more specific alcoholic beverages are identified, such as caffeinated alcoholic beverages (e.g., Linden-Carmichael & Lau-Barraco, 2017). In sum, alcohol consumption level is measured via a variety of indicators, but a standardized approach has been created and utilized. Recently, there has been

a push to expand type of alcoholic beverage with increasingly popular types of alcoholic beverages available, such as hard seltzer and cider (Grand View Research, Inc., 2019; Huddleston Jr., 2019).

Unlike measurement of alcohol use, quantity, frequency, and potency of cannabis use measures are still being developed. In terms of frequency, researchers have asked participants to indicate how many days in the past month they have used cannabis (e.g., Prince & Conner, 2019) or adapted known measures of alcohol use frequency (e.g., Pearson et al., 2018). Pearson et al. (2018) modified the Daily Drinking Questionnaire (Collins et al., 1985) by breaking down each day into 4-hour blocks of time, then asking participants to report in which block of time they typically used cannabis in the last 30 days. Unlike standard drinks of alcohol, which are easily understood by most participants and equivalent in potency, there are various routes of administration for cannabis, which vary in potency. Researchers have assessed potency by asking participants to self-report the percentage of Δ9-tetrahydrocannabinol (THC) for the routes of administration they use (e.g., Prince & Conner, 2019). Prince and Conner (2019) cautioned that cannabis potency should be analyzed distinctly across the various routes of administration to understand associations between potency and health outcomes. This is due to finding a large gap between cannabis flower potency (20% THC) and concentrated cannabis product potency (76% THC; Prince & Conner, 2019). Research is still determining the best method for cannabis use measurement; however, it is clear that potency is important to assess with route of cannabis administration.

Theoretical Framework – Co-use of Alcohol and Cannabis

Alcohol and cannabis can be used on their own as well as at the same time. There are two concepts or notions regarding why individuals participate in polysubstance use. Behavioral

economists have discussed how substances can be used as either substitutes (using substances independently) or complements (one substance is enhanced by the other) to each other (Hursh et al., 2005). From a practical perspective, substitution occurs when one substance's use is increased while the other is decreased and complementary use would occur when increased use of one substance increases use of the other substance (Subbaraman & Kerr, 2015). In regard to using both alcohol and cannabis, both concepts have found support depending on the population and environment (Subbaraman, 2016). Among college students, it was found that alcohol and cannabis are most used as complements to each other rather than substitutes (e.g., Ito et al., 2021; O'Hara et al., 2016; Williams et al., 2004). Williams et al. (2004) examined data from the 1990's that was collected as part of the Harvard School of Public Health's College Alcohol Study. They discovered that alcohol and cannabis were economic complements in college students, in that there was a negative association between price of cannabis and using alcohol and cannabis (Williams et al., 2004). In other words, as the price of cannabis increased, the use of both alcohol and cannabis decreased, showing that affecting one substance's price does not inversely the use of the other substance. If the price of cannabis increased and the use of cannabis decreased but the use of alcohol increased, this would demonstrate that they were economic substitutes. Ito et al. (2021) assessed alcohol and cannabis use over 28 days using the Timeline Follow Back (Sobell & Sobell, 1992) three times over three years and found that on days when cannabis was used, more alcohol was consumed than on days when cannabis was not used. In addition, O'Hara et al. (2016) discovered that among undergraduate students who participated in a 30-day daily diary study, more alcohol consumed predicted greater likelihood of cannabis use. However, when students self-reported using substances as a coping strategy, O'Hara et al. (2016) found that students who were more likely to use alcohol were also less likely to use cannabis,

suggesting support for the substitution theory among users for coping purposes. The theories of substitution and complementary use can potentially be reconceptualized as using substances "concurrently" (substitution; effects do not overlap) versus "simultaneously" (complementary; effects overlap; Earleywine & Newcomb, 1997; Subbaraman & Kerr, 2015). However, it is not completely known if those who use alcohol and cannabis simultaneously are actually using the substances to complement each other, or if those who use alcohol and cannabis concurrently are truly substituting the two substances (Subbaraman & Kerr, 2015).

Simultaneous Alcohol and Cannabis Use

Simultaneous alcohol and cannabis (commonly referred to as simultaneous alcohol and marijuana [SAM]) use, sometimes called being "cross-faded" (Patrick & Lee, 2018), tends to be more popular than concurrent alcohol and cannabis (commonly referred to as concurrent alcohol and marijuana[CAM]) use among adults who participated in the National Alcohol Survey (Subbaraman & Kerr, 2015). Among adolescents, Patrick, Kloska, et al. (2018) found that if participants were using both alcohol and cannabis, most were using the substances simultaneously. One recent study that surveyed college students who used both substances in the past year found that 73% of participants used alcohol and cannabis simultaneously at least once in the past year (White et al., 2019). Consequences of SAM use have been found to be greater than those of concurrent use or single substance use of alcohol and cannabis (as described in greater detail below; Duckworth & Lee, 2019; Jackson et al., 2020). Due to the prevalence and consequences of SAM use being greater than concurrent use, more research is needed to further understand SAM use, specifically among college students.

SAM Consequences, Motives, Expectancies, Contexts, and Type of Alcohol/Route of Cannabis Administration

Consequences. Similar to using substances on their own, there are specific consequences, motives, and expectancies related to SAM use (e.g., Duckworth & Lee, 2019; Jackson et al., 2020; Midanik et al., 2007). SAM use is associated with greater social consequences across five problem areas (health, fight, relationship, legal/accidents, and work problems; Midanik et al., 2007). For example, Duckworth and Lee (2019) examined single substance, concurrent, and SAM use along with risky driving behaviors, including driving under the influence, in a sample of young adults and found that SAM users were more likely to endorse and participate in risky driving behaviors compared to single and co-substance users. In a sample of college students, Jackson et al. (2020) examined if the frequency of substance-related consequences varied between SAM, single substance use, and CAM users. Using a measure that collapsed the Brief Young Adult Alcohol Consequence Questionnaire (BYAACQ; Kahler & Strong, 2005) and the Brief Marijuana Consequences Questionnaire (BMCQ; Simons, Dvorak, Merrill, & Read, 2012) into a single measure with 28 unique items in which participants selected if a consequence occurred due to their alcohol and/or marijuana use, Jackson et al. (2020) found that past 3-month SAM users endorsed more consequences than CAM users or single-substance users who only use alcohol. Furthermore, specific consequences have been found to be more of a risk for SAM than CAM users (Cummings et al., 2019). In a sample of freshman college students who endorsed cannabis and alcohol use in the previous three months, Cummings et al. (2019) found that SAM users experienced more academic consequences and were at a higher risk of experiencing alcohol-related blackout than CAM users. Additionally, Looby et al. (2021) compared college student past-month dual users (did not use alcohol and cannabis together in the

same use session) to past-month SAM users and found that SAM users reported more cannabis-related consequences. In contrast to these studies, Sokolovsky et al. (2020) found that in a sample of college students who participated in a 28-day daily diary study (more information below), SAM and CAM use consequences were not significantly different from each other at the daily level. Knowing that there are contrasting results between cross-sectional and daily studies, it is important to further examine if consequences of SAM and CAM use differ at the daily level, as well as if cognitions (motives, expectancies) and contexts (environmental, social) vary across SAM versus CAM use.

Motives. Specific reasons for using alcohol and cannabis independently are also associated with SAM use (Terry-McElrath et al., 2013). Higher odds of SAM use frequency were associated with endorsing the following reasons for using alcohol: "to feel good or get high", "because it tastes good", "because of boredom, nothing else to do", "to increase effects of some other drug(s)", and "because I am 'hooked' – I feel like I have to drink". In terms of cannabis-related reasons, higher odds of SAM use frequency were associated with endorsing these reasons for using cannabis: "to feel good or get high", "because I'm 'hooked' – I have to do it", "to fit in with a group I like", and "To increase effects of some other drug(s)" (Terry-McElrath et al., 2013). Further research, using a scale that combined the Comprehensive Marijuana Motives Questionnaire (CMMQ; Lee et al., 2009) and Modified Drinking Motives Questionnaire – Revised (DMQ-R; Grant et al., 2007), discovered that SAM use was associated with specific motives in a young adult population (Patrick et al., 2019). Using multilevel modeling, Patrick et al. (2019) specifically found that among young adult past-month SAM users, there was a positive association between SAM use and conformity (e.g., "So I wouldn't feel left out") and enhancement (e.g., "To feel good") motives. This study utilized a scale that

combined two well-known measures for determining motives for alcohol and cannabis use separately.

Furthering the measurement of SAM motives, Patrick, Fairlie, et al. (2018) created a scale to specifically measure motives for SAM use. Within this measure, four categories were identified: conformity (e.g., “Because others are doing it”); positive effects (e.g., “Cross-faded effects are better”); calm/coping (e.g., “To help me sleep”); and social (e.g., “Because it is customary on special occasions”). This measure demonstrated a significant association between specific motives and likelihood of SAM use within a sample of young adults who were part of a larger longitudinal study (Patrick, Fairlie, et al., 2018). For participants who used alcohol and cannabis simultaneously in the past month, those who had higher conformity SAM motives were less likely to report SAM use. However, those who reported higher social SAM motives were more likely to report SAM use. Conway et al. (2020) validated this measure in a sample of college students who reported SAM use in the past year. Using the same sample, the authors also developed a brief version of the SAM motives measure and found similar results to the original measure by Patrick, Fairlie, et al. (2018). There was a significant association between all SAM use motives and SAM use frequency. Those who reported greater conformity motives participated in SAM use less frequently. Those who reported greater positive effects, calm/coping, and social motives participated in SAM use more frequently. Additionally, a positive association was found between specific motives and SAM consequences, such that stronger conformity, positive effects, and social motives were associated with reporting more SAM use consequences (Conway et al., 2020). More research is needed to further understand the motives behind SAM use using the specific SAM use measure, both the original and brief versions, especially in the college student population. Moreover, no one has yet examined SAM-

specific motives at the daily level, or if SAM motives vary by type of alcohol and route of cannabis administration

Expectancies. SAM expectancies have also been found to predict use in a sample of adult SAM users (Barnwell & Earleywine, 2006). Barnwell and Earleywine (2006) created a measure to assess SAM expectancies using known measures for only alcohol (Alcohol Expectancy Questionnaire [AEQ]; Brown et al., 1987) and only cannabis (Marijuana Effect Expectancy Questionnaire [MEEQ]; Schafer & Brown, 1991). If participants endorsed an item from the AEQ (Brown et al., 1987), they were asked how marijuana alters the effect. The same approach was used when participants endorsed an item from the MEEQ (Schafer & Brown, 1991); they were asked how alcohol alters this effect. There was no follow-up question asked if the expectancy item was not endorsed. This measure predicted SAM use above and beyond expectancies specific to alcohol or cannabis only (Barnwell & Earleywine, 2006). However, Barnwell and Earleywine (2006) had a flaw in their analysis; specifically, the way in which the expectancy scores were calculated for SAM use. The sum of the scores were utilized, rather than the mean, not taking into account expectancies that were not endorsed. In other words, a lower score could indicate a less intense expectancy (i.e., the other substance would lessen the effects of the first substance, or not intensify it), but it could also indicate not endorsing as many expectancies originally for alcohol alone or marijuana alone. The current study will address this flaw by examining the mean for items endorsed and make a significant contribution to the literature. Additionally, as with the SAM use motives scale from Patrick, Fairlie, et al. (2018), more research is needed to understand expectancies related to SAM use outcomes, specifically within the college student population as only one study has examined SAM expectancies; moreover, no one has yet examined them at the daily level. In addition to fixing a measurement

flaw and adding a daily examination of SAM expectancies to the literature, the current study will expand upon these findings by examining the link between SAM expectancies and type of alcohol and route of cannabis administration.

Contexts. Simultaneous use of alcohol and cannabis is dependent on environment and social context (e.g., Egan et al., 2019; Lipperman-Kreda et al., 2018; Looby et al., 2021). Using data collected by a computer-assisted telephone survey that asked about substance use the "last time participants were in a social gathering at each of four places (i.e. their own home; someone else's home; bars/restaurants; or outdoor/public places like a park, beach or camping area)" (Lipperman-Kreda et al., 2018, p.189), the authors found that young adults in California were less likely to engage in SAM use in bars and restaurants compared to outdoor places. They also found no association between number of people present and SAM use; however, if more than half of the people at an event were perceived to be intoxicated, there was a seven-fold increase in the odds of SAM use (Lipperman-Kreda et al., 2018). In a national sample of youth and young adults who were part of a larger prospective study, Egan et al. (2019) found that using alcohol and cannabis simultaneously while at a party was significantly associated with experiencing more negative consequences, after controlling for variables such as level of alcohol consumption, the context of the party, other substance use, demographics, and cannabis policy for the states in the study (Egan et al., 2019). In a cross-sectional study of college students, Looby et al. (2021) found that participants who participated in SAM use in the past-month were more often using cannabis at parties than dual users (did not use alcohol and cannabis during the same use session). Prior research has focused on adolescents and young adults generally, with limited research being conducted within the college student population. More information regarding

environmental and social context is needed specifically for college students who participant in SAM use.

Daily Diary Methodology

The literature on SAM use using daily diary methodology is expanding, with only a limited number of studies being conducted in the college student population. Brown et al. (2018) examined SAM use associations with odds of interpersonal conflict in undergraduate freshman males over a period of 56 days and found that odds of interpersonal conflict were not increased for SAM use days more so than when alcohol or cannabis are used on their own. Sokolovsky et al. (2020), as part of a larger study (see White et al., 2019), assessed college students five times daily over 28 days to examine if SAM and CAM use predicted later consequences reported. They found that on days when students reported SAM or CAM use, they reported more negative consequences than on days when they used alcohol and cannabis separately (Sokolovsky et al., 2020). Lee, Patrick, et al. (2020) conducted a study in which young adult participants self-reported alcohol use, SAM use, and alcohol-related consequences over two 14-day periods, in the morning and in the afternoon. The authors found that young adults consumed more alcohol on days when they participated in SAM use, as compared to days when they only consumed alcohol. Similarly, participants self-reported experiencing more alcohol-related consequences on SAM use days than on alcohol-only days. In contrast, in a 14-day diary study Linden-Carmichael et al. (2020) found that there was not a difference in quantity of alcohol consumption between SAM use days and alcohol-only days. However, Linden-Carmichael et al. (2020) found that more negative consequences were self-reported on SAM-use days when comparing to alcohol- or cannabis-only days. Using the same methodology, Patrick et al. (2019) investigated changes in motives for alcohol and/or cannabis use (one measure for both substances) across days and if

they predicted alcohol, cannabis, and SAM use. The authors found that there was a greater chance of SAM use over alcohol-only use on days when coping, enhancement, or conformity motives were greater. There was also a greater chance of SAM use over cannabis-only use on days when social, enhancement, or conformity motives were greater. Only a handful of studies have examined SAM use at the daily level, focusing on consequences and motives. Not much is known about the associations between SAM use and expectancies, contexts, and type of alcohol and route of cannabis administration on the daily level.

The Current Study

Exploratory work has been conducted regarding motives, expectancies, and social context as predictors of simultaneous use of alcohol and cannabis among college student (e.g., Barnwell & Earleywine, 2006; Lipperman-Kreda et al., 2018; Patrick et al., 2018a) with limited studies conducted on the daily level or event level (e.g., Brown et al., 2018; Linden-Carmichael et al., 2020; Patrick et al. (2019); Sokolovsky et al., 2020). In particular, more information is needed regarding context of SAM use in college students, with no studies to date examining this at the daily or event level. Moreover, the type of alcohol or route of cannabis administration has been investigated in studies focusing on single or overall substance use (e.g., Mochrie et al., 2019; Prince & Conner, 2019; Reboussin et al., 2019; Steigerwald et al., 2018); however, it has not been investigated for using both substances simultaneously. The current study sought to address this gap by identifying if and how type of alcohol/route of cannabis administration is associated with SAM or single substance use and also expand the literature by comparing alcohol- and cannabis-related motives and expectancies between SAM and CAM users. Lastly, the current study sought to expand the literature on SAM consequences, motives, and expectancies by

examining the relationship between these constructs with type of alcohol and route of cannabis administration.

The purpose of the current study was to identify the type of alcohol and route of cannabis administration that college students use when they use both substances simultaneously (as compared to separately or alone), as well as the consequences, motives, expectancies, and environmental/social contexts associated with SAM use, and if these vary across type of alcohol and route of cannabis administration used during SAM use. The aims of the current study were:

Aim 1: Identify the most common type of alcohol and route of cannabis administration used by college students on days when using these substances simultaneously, versus separately, and examine if the quantity of alcohol and cannabis used varies across type of alcohol and route of cannabis.

a. Research Question 1.1: Research has shown that the most common route of cannabis administration when using it on its own is smoking (e.g., Reboussin et al., 2019; Steigerwald et al., 2018). This study attempted to replicate that finding . Therefore, it was expected that the most commonly reported route of administration for cannabis would be smoking.
b. There is not much known about which type of alcohol college students most commonly use on its own from a daily perspective; therefore, Research Question 1.2 asked what were the frequencies of different types of alcohol consumed?
c. Similarly, not much is known regarding the type of alcohol and route of cannabis administration used when participating in SAM use. Therefore, Research Question 1.3 asked if rates of type of alcohol and route of cannabis administration

would be different when using the substances on their own versus on days when they are both used.

d. In addition, not much is known about the quantity of alcohol and cannabis used across the types of alcohol and cannabis administration. Therefore, Research Questions 1.4 and 1.5 asked if the quantity of alcohol (RQ 1.4) and cannabis (RQ 1.5) used varies across type of alcohol (RQ 1.4) and route of cannabis administration (RQ 1.5).

Aim 2 (*SAM and CAM days only)*: Examined if consequences, motives, expectancies, contexts, and quantity used varied on SAM versus CAM days.

a. Hypothesis 2.1: Research has compared SAM use consequences to CAM use consequences with contrasting results (e.g., Jackson et al., 2020; Sokolovsky et al., 2020). Therefore, the present study examined this issue in a sample of college students. It was expected that on SAM use days, participants would experience more consequences than on CAM use days.

b. There is not much known about the differences in alcohol- and cannabis-related motives between SAM and CAM use days, thus, Research Question 2.1 asked if motives for alcohol and cannabis use vary across SAM versus CAM use days.

c. Similarly, research has not compared alcohol- and cannabis-related use expectancies between SAM and CAM use. Therefore, Research Question 2.2 asked if these expectancies for alcohol use and cannabis use vary across SAM and CAM use days.

d. Research has found that when using alcohol and cannabis simultaneously, it is expected that students will be in outdoor places and with others present. However,

there is not much known about the differences in environmental and social contexts for SAM versus CAM use. Therefore, Research Questions 2.3 and 2.4 asked if environmental (RQ 2.3) and social context (RQ 2.4) vary across SAM and CAM use days.

e. Hypothesis 2.2: Research has found that quantity of alcohol consumed by adults is higher for SAM use than CAM use (Subbaraman & Kerr, 2015). Therefore, the present study examined if this finding was replicated in a sample of college students. It was expected that on SAM use days, the quantity of alcohol consumed would be higher than on CAM use days.

f. Research has found that SAM use is associated with higher frequency of cannabis use among adults as compared to CAM use (Subbaraman & Kerr, 2015). However, measurement of quantity of cannabis used is developing, limiting the number of studies that have examined quantity of cannabis, with no published research comparing SAM and CAM cannabis quantity used. Therefore, Research Question 2.5 asked if quantity of cannabis used varies across SAM and CAM use days.

Aim 3 (*SAM days only)*: Examined if SAM-specific consequences, expectancies, motives, and contexts vary based on the type of alcohol and route of cannabis administration used.

a. Hypothesis 3.1: Research has shown that higher potency routes of administration of cannabis (e.g., higher potency concentrate products such as wax [a form of concentrate]) are associated with negative consequences during single use (e.g., Prince & Conner, 2019; Steigerwald et al., 2018). This study determined if this

finding was replicated during SAM use, therefore, it was expected that those who used concentrates would have greater SAM consequences than other routes of administration.

b. Hypothesis 3.2.: Research has shown that consuming liquor is associated with more consequences during single use (e.g., Mochrie et al., 2019). This study determined if this finding was replicated for SAM use; therefore, it was expected that those who drink liquor, as mixed drinks or shots, would experience greater SAM consequences.

c. Similarly, there is not much research regarding SAM motives in general, especially in conjunction with type of alcohol and route of cannabis administration used. Therefore, Research Question 3.1 asked if SAM motives (conformity, positive effects, calm/coping, and social) vary across type of alcohol and route of cannabis administration.

d. There is not much known regarding the variance of SAM expectancies by type of alcohol and route of cannabis administration for SAM use. Thus, Research Question 3.2 asked if SAM expectancies (relaxation and tension reduction expectancies) vary across type of alcohol and route of cannabis administration when using alcohol and cannabis simultaneously.

e. Research Questions 3.3-3.4: There is not much known regarding variability of environmental and social context by type of alcohol and route of cannabis administration of SAM use. Therefore, Research Questions 3.3 and 3.4 asked if environmental (RQ 3.3) and social context (RQ 3.4) vary across type of alcohol and route of cannabis administration.

CHAPTER II

METHOD

Participants

A total of 18 participants (M_{age} = 21.72 years, *SD* = 1.93) were recruited for this study, using Sona and student announcements at the host institution, Sona and student announcements in neighboring institutions, and flyers in the community. The advertisements included a description of the study and eligibility criteria. The study description explained that the study is examining alcohol and cannabis use, noted that cannabis use is illegal at the federal level, and their related consequences, cognitions, contexts, and types, and included brief daily surveys sent for 21 consecutive days (see Appendix A). Eligibility criteria included: 1) being between the ages of 18-25 years old, 2) being an undergraduate or graduate student, 3) endorsing SAM use at least twice in the past 14 days and 4) having at least daily access to a reliable device that connects to the internet. Participants in the current sample were mostly cisgender women (61.1%), White (77.8%), and were enrolled full-time (88.9%; see Table 1 for detailed demographic information).

Participants were compensated with three different methods: 1) Sona credit, 2) gift card payments, or 3) a mix of both compensation methods. Students who wanted Sona credit for compensation were compensated with research credit. Participants received 1 credit for completing baseline and up to 3 credits for completing all 21 days, for a total of 4 possible credits. Research credits during the daily portion of the study were awarded as follows: 0 days (0 credits), 1-2 days (.5 credits), 3-6 days (1 credits), 7-10 days (1.5 credits), 11-14 days (2.0 credits), 15-17 days (2.5 credits), and 18-21 days (3 credits). If more than 85% of the daily surveys were completed (18+ days), participants were entered into a raffle for one of four $25

Amazon gift cards. Those who chose gift card payments for compensation received $5 for the baseline survey, then $0.75 for each daily survey plus a $6 bonus if they completed at least 18 daily surveys, for a total of up to $26.75 total in Amazon gift cards. Those who enrolled in the study after the deadline to receive research credit for the daily surveys or who opted to receive Sona credit only for baseline were compensated with 1 Sona credit at baseline and up to a $21.75 Amazon gift card for the daily surveys. This study was approved by the Old Dominion University Institutional Review Board (IRB). Before expanding to data collection at other institutions, at least one institution required their IRB to review the study as well. I secured a Certificate of Confidentiality from the National Institutes of Health, providing protections against disclosure of information that may identify participants in any federal, state, or local civil, criminal, administrative, legislative, or other proceedings.

Table 1

Demographic and Substance Use Information for Participants

Variables	*M* (*SD*)
Age	21.72 (1.93)
Past 30-day alcohol use frequency (days)	12.06 (7.12)
Typical week alcohol use frequency (days)	3.94 (1.63)
Typical week cannabis use frequency (days)	5.89 (1.75)
	n (%)
Gender	
Cisgender men	6 (33.3%)
Cisgender women	12 (61.1%)
Other	1 (5.6%)
Race	
White	14 (77.8%)
Black	3 (16.7%)
Multiracial	1 (5.6%)
Hispanic/Latinx (yes)	2 (11.1%)
Student status	
Full-time	16 (88.9%)
Part-time	2 (11.1%)
Class standing	
Freshman	3 (16.7%)
Sophomore	4 (22.2%)
Junior	1 (5.6%)
Senior	5 (27.8%)
Graduate	5 (27.8%)
First-generation college student (yes)	4 (22.2%)
Residence	
On-campus	1 (5.6%)
Off-campus	15 (83.3%)
Compensation for baseline	
Monetary compensation	11 (6.1.%)
Sona credit	7 (38.9%)
Compensation for daily surveys	
Monetary compensation	11 (61.1%)
Sona credit	7 (38.9%)

Procedure

After reviewing the study description and eligibility criteria, participants were directed to an online screener survey, which included questions based on the eligibility criteria as well as distractor questions to confirm eligibility. If participants were eligible, they were given the option of either completing the baseline survey right away, or later. If they selected later, they provided their email address so that a link to the baseline survey could be sent via email (see Appendix C). Once directed to the baseline survey, they read information about the study, viewed associated videos, and provided informed consent. The videos were created in a cartoon video editor and featured a voiceover with clipart images, none of which were related to a specific gender or race/ethnicity. These videos further explained the purpose of the study, the daily diary protocol, the types of questions in the surveys, and the compensation structure (see Appendix B for scripts of these videos). Contact information for the researcher was provided in case of any questions or concerns. After providing consent by clicking the arrow at the end of the informed consent form, participants were directed to an online baseline survey. After completing the baseline survey, participants were directed to review a video that re-iterated the daily diary protocol, the types of questions in the daily surveys, and the compensation structure (see Appendix B). Prior to enrollment in the daily portion of the study, eligibility criteria were verified as well as attention check criteria (see below). If participants did not meet eligibility criteria or if they failed attention checks, they were not enrolled in the daily portion of the study. These participants (n = 31) received an email informing them of their ineligibility (see Appendix C). Those who met eligibility criteria and did not fail attention checks received an email inviting them to complete the daily portion of the study (see Appendix C). Participants were given a list of seven consecutive dates and asked when they would like the surveys to begin. The daily

surveys began on the day each participant chose and continued for 21 consecutive days from the day the participants completed their first daily survey. By sending the invitations for the daily surveys any day of the week, day of week was not conflated with day of study. Consistent with previous SAM-use daily diary studies (Linden-Carmichael et al., 2020), surveys were sent to participants via email at 9am (see Appendix C for the email invitation). Participants were instructed to complete the survey by 2pm to report their behaviors from the previous day; however, the link did not become inactive until the following day at 9am. If participants reported that they used alcohol and/or cannabis the previous day, they received questions about their alcohol and/or cannabis use (i.e., quantity), type of alcohol and/or route of cannabis administration, consequences, motives, expectancies, and context. If participants did not report using either substance, they were asked questions related to other behaviors to balance for time (see Appendix D for a flow chart of the daily survey measures). Reminders were sent to participants via email or text message (based on their indicated preference) if they did not complete three consecutive daily surveys (see Appendix C).

Materials

After providing informed consent, participants completed a survey assessing their past 30-day alcohol and cannabis use (single, co-, and simultaneous use) as well as related consequences, motives, and expectancies. Typical environmental context, typical social context, and demographics were also assessed. For the current study, the only baseline measures used in analyses were gender and alcohol and cannabis use frequency. Eligibility to be enrolled in the daily surveys were confirmed with questions at baseline. Daily surveys included measures of similar constructs, depending on type of substance use reported that day (alcohol-only, cannabis-only, CAM, SAM, or no-use).

Alcohol and Cannabis Use

Baseline. Frequency of past 30-day alcohol use was assessed at baseline by first asking participants if they consumed alcohol in the past 30 days, and if yes, how many days in the past 30 days they consumed alcohol. Participants were able to select a number of day(s) from 0-30 (see Appendix E).

Daily. Daily surveys began by prompting students to think about their behaviors for the previous day, specifically "the time period from when you woke up until you went to sleep the day before today (yesterday)" (Bravo et al., 2017; see Appendix F). For the daily surveys, participants were asked if they consumed alcohol the previous day. If participants recorded that they used alcohol the previous day, they were asked to report the number of standard drinks they consumed (i.e., alcohol quantity, see below). Before each survey, participants were reminded of standard drink sizes (NIAAA, n.d.) using an image of examples of standard drink sizes, including hard seltzer, beer, craft beer, wine, and 80 proof liquor (Appendix G). Linden-Carmichael et al. (2020) utilized a similar question for daily alcohol consumption in a sample of young adults. For cannabis use at the daily level, participants were asked if they consumed marijuana the previous day (see Appendix F). If participants record that they used marijuana the previous day, they were asked to report the amount of cannabis used (in grams), which equaled the quantity of cannabis consumed that day (Prince, 2019). Pictures of cannabis quantity examples were provided (Bravo et al., 2017; see Appendix H).

Type/Route of Administration

Daily. For type of alcohol consumed, participants selected all types of alcoholic beverages they used the previous day from the following choices: *beer, hard cider, wine, mixed drinks (liquor), hard seltzer, shots (liquor),* and *other (please describe)*. If a participant selected

mixed drinks, they were asked if mixed drinks included alcohol mixed with caffeinated beverages (see Appendix I). These alcoholic beverage choices were modified from a study on beverage preference and alcohol-related negative consequences within a college student sample (Mochrie et al., 2019). I added the options of hard cider and hard seltzer to reflect modern drinking trends, and added alcohol mixed with caffeinated beverages as a follow-up to mixed drinks rather than a separate category given its overlap with mixed drinks.

For route of cannabis administration, participants selected all routes of cannabis administration they used the previous day from the following choices: *plant (e.g., smoking bud, flower), concentrates (e.g., hash, dabs), edibles (e.g., brownie, chocolate), topical (e.g., lotions, creams),* or *other (please describe;* see Appendix J). Previously, these routes of administration have been assessed among cannabis users exclusively in a state where recreational cannabis use is legalized (Prince & Conner, 2019).

Simultaneous and Concurrent Use

Baseline. Based on Earleywine and Newcomb's (1997) definition of SAM use, SAM use was assessed at baseline (for eligibility) by asking participants, "How often in the past 14 days did you use alcohol and marijuana at the same time so that their effects overlapped?" This style of question has been used to assess SAM use in college student samples (e.g., Jackson et al., 2020; White et al., 2019). Participants provided a response ranging from 0 - 14 days (see Appendix K).

Daily. Each morning during the daily surveys, if participants reported that they used both alcohol and cannabis the previous day, they were asked, "Did you use alcohol and marijuana at the same time yesterday, such that their effects overlapped?" (Linden-Carmichael et al., 2020;

Appendix F). If yes, participants moved forward with completing assessments related to SAM use. If no, participants completed assessments related to CAM use.

Alcohol, Cannabis, and SAM-Related Negative Consequences

Daily. Negative consequences were assessed using a method developed by Jackson et al. (2020) and Sokolovsky et al. (2020; see Appendices L & M). Negative consequences from the Brief Young Adult Alcohol Consequences Questionnaire (BYAACQ; Kahler et al., 2005) and the Brief Marijuana Consequences Questionnaire (BMCQ; Simons et al., 2012) were collapsed to create a measure with 28 unique items (Jackson et al., 2020). Sokolovsky et al. (2020) narrowed this measure to seven items for a daily diary study. For the proposed study, I narrowed the measure to five items to reduce participant burden and focus on items that may happen more often at the daily level then in a longer time frame. Instructions were also adapted for daily use (i.e., instructions modified to reflect yesterday rather than the past month). Question prompt and response options were different based on SAM use versus non-SAM use, but item text (i.e., potential consequences) were the same. Those who reported SAM use saw the following prompt:

> 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 [yesterday]. (Jackson et al., 2020, p. 4).

Participants reporting SAM use were able to select all four options (select all that apply): *attribution to alcohol alone, marijuana alone, alcohol and marijuana together*, and *have not experienced this consequence*. Those who reported alcohol and/or cannabis use but not SAM use

saw the following instructions before the items and indicated which consequences they experienced for each substance individually:

> 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 [yesterday]. (Jackson et al., 2020, p. 4)

Participants were able to select up to three options (select all that apply): *attribution to alcohol alone, marijuana alone,* and *have not experienced the consequence*. For both versions of the scale (SAM or non-SAM), each consequence was coded as 1 if it was reported as experienced (no matter if it was due to alcohol and/or cannabis), or coded as 0 if it was reported as not experienced. Items were summed (score ranges from zero to five)

Alcohol-Related Motives

Daily. If participants report using alcohol the previous day, they completed a version of the Modified DMQ-R (Grant et al., 2007), modified for daily use. Five items from Merrill et al.'s (2019) daily study were utilized, with the following answer choices: 0 = *no,* 1 = *yes*. These five items aligned with the five subscales (one item each) from the Modified DMQ-R (Grant et al., 2007): *social* ("To make the day/night more fun"); *coping-anxiety* ("To feel less nervous/anxious"); *coping-depression* ("To feel less depressed"); *enhancement* ("To get high, buzzed, or drunk"); and *conformity* ("To not be left out"; Merrill et al., 2019). Participants were asked, "The following are a list of reasons people sometimes give for drinking alcohol. Why did you drink yesterday?" (O'Hara et al, 2015; see Appendix N). Each motive had its own score for each alcohol-use day (0, 1). Both the questions and answer choices have been utilized in daily surveys among a sample of college students (Merrill et al., 2019).

Cannabis-Related Motives

Daily. If participants report using cannabis the previous day, they completed a version of the Comprehensive Marijuana Motives Questionnaire (CMMQ; Lee et al., 2009) modified for daily use. Only five items were asked to reduce participant burden. Questions were first narrowed to one per each of the 12 factors based on the highest loading factor from Lee et al. (2009). From this list, I further narrowed to items that seemed to align better with daily alcohol motives (i.e., conformity, coping, enjoyment [similar to enhancement]) and ones that appear to be more representative of daily motives for using cannabis (i.e., availability, boredom, celebration). Lastly, I combined two items (for availability and boredom) to reach the final item count of five. The five items aligned with the following motives from the CMMQ (Lee et al., 2009): *conformity* ("To be cool"); *availability/boredom* ("Because it was there and you had nothing better to do"); *celebration* ("To celebrate"); *coping* ("To forget your problems"); and *enjoyment* ("To enjoy the effects"). Participants were asked, "The following are a list of reasons people sometimes give for using marijuana. Why did you use marijuana yesterday?" (modified from O'Hara et al., 2015; see Appendix O). Answer choices included 0 = *no,* 1 = *yes*. Each motive had its own score for each cannabis-use day (0, 1). The full questionnaire has been utilized with college student samples (e.g., Lee et al., 2009).

SAM-Related Motives

Daily. The Brief SAM Motives Measure (B-SMM; Conway et al., 2020), modified for daily use, was utilized for the daily surveys if participants reported SAM use the previous day (i.e., "Why did you use alcohol and marijuana simultaneously yesterday?"). This brief measure was adapted from the original Patrick, Fairlie, et al. (2018) SAM motives measure. Conway et al. (2020) adapted the original Patrick, Fairlie, et al. (2018) measure for settings or projects that

would benefit from a briefer measure, such as daily diary studies. Conway et al. (2020) first validated the Patrick, Fairlie, et al. (2018) measure in a sample of college students. Then, Conway et al. (2020) created the brief measure by removing or keeping items based on factor loadings criteria. I further reduced the number of items to five. Items were selected based on which ones had the highest factor loading for each of the four factors; however, two positive effect items were kept. These items assessed the same four overall motives as the original brief measure (Conway et al., 2020): *conformity* ("To fit in with a group I like"); *positive effects* ("To increase the positive effects I get from alcohol" and "To increase the positive effects I get from marijuana"); *calm/coping* ("To calm me down"); and *social* ("As a way to celebrate"). Response options were 0 = *no*, 1 = *yes* (see Appendix P for the full measure, including items included versus omitted). Each motive had its own score for each SAM-use day (0, 1). *Positive effects* were scored separately for each substance. In other words, there is one score for positive effects of alcohol and one score for positive effects of cannabis. The original B-SMM (Conway et al., 2020) has been utilized in a sample of college students from multiple campuses.

Alcohol, Cannabis, and SAM-Related Expectancies

Daily Alcohol. At the daily level, alcohol expectancies were assessed prospectively, or at the beginning of each day. A modified version of the Alcohol Expectancy Questionnaire – Revised (AEQ-R; Brown et al., 1987) was utilized. It has previously been adapted to examine SAM-related expectancies, as described in more detail below (Barnwell & Earleywine, 2006). The AEQ-R has six subscales; however, only the *relaxation and tension reduction* subscale was utilized to align with the measurement of SAM-related expectancies (Barnwell & Earleywine, 2006). Barnwell & Earleywine (2006) used two subscales for alcohol expectancies in their method (i.e., *relaxation and tension* and *global positive changes*); however, the current study

used only one subscale as it is shared with the cannabis expectancies measure (see below). In addition, the other alcohol subscale was counter to the cannabis expectancies subscale that was used by Barnwell and Earleywine (2006; *global negative changes*); this also reduced participant burden. Participants were asked, "What are you expecting or anticipating will happen IF you drink alcohol later today? (please answer as if you were going to drink alcohol, even if that is not your intention)" Items were modified for daily responses, based in part by the items from Butler et al. (2010; e.g., "Alcohol helps me to be in a better mood"). Response options included, 1 = *Yes, I am expecting this,* and 0 = *No, I am not expecting this.* Responses were dichotomized similar to Barnwell & Earleywine (2006). Only three items from the AEQ-R (Brown et al., 1987) *relaxation and tension reduction* subscale were used to further reduce participant burden. Items were narrowed for the current study based on those that seemed more representative for daily expectancies (see Appendix Q for the full measure, denoting items included versus omitted). Scores were summed for each day (0-3). One follow-up question was asked for each expectancy and varied depending on participant endorsement of each expectancy. For endorsed items, participants were asked how marijuana alters this effect (see Daily SAM use below). To balance the number of questions, if participants did not endorse an expectancy, they were asked, "How does drinking more alcohol alter this effect?". Response options included -3 = *make it less intense* – 3 = *make it more intense* (Appendix Q). These follow-up items did not contribute to the alcohol expectancy score but were present to balance time due to the additional follow-up questions on SAM use days (see below).

Daily Cannabis. Cannabis expectancies were assessed prospectively, or at the beginning of each day. A modified version of the Marijuana Effects Expectancy Questionnaire (MEEQ; Schafer & Brown, 1991) was utilized. It has previously been adapted to examine SAM-related

expectancies (Barnwell & Earleywine, 2006). The MEEQ (Schafer & Brown, 1991) has six subscales; however, only the *relaxation and tension reduction* subscale was utilized to align with the measurement of SAM-related expectancies (Barnwell & Earleywine, 2006). As previously mentioned, Barnwell & Earleywine (2006) used an additional subscale (*global negative effects*), however, only the *relaxation and tension reduction* subscale was used to align with the alcohol expectancies measure and to reduce participant burden. Participants were asked, "What are you expecting or anticipating will happen IF you use marijuana later today? (please answer as if you were going to use marijuana, even if that is not your intention)". Response options were identical to the alcohol-expectancies scale (i.e., 1 = *Yes, I am expecting this,* and 0 = *No, I am not expecting this*). Items were modified for daily responses (e.g., "I am more relaxed in social situations after using marijuana and do not feel insecure"). Only three items were utilized to reduce participant burden. Items were narrowed for the current study using the same method for the alcohol expectancy items (i.e., more representative of daily experiences). Scores were summed for each day (0-3). Similar to alcohol expectancies, a follow up question was asked for each item. For endorsed items, participants were asked how alcohol alters this effect (see Daily SAM use below). For items a participant did not endorse, they were asked, "How does using more marijuana alter this effect?" to balance for time/number of items. Response options were the same as those for alcohol expectancies (i.e., -3 = *make it less intense* to 3 = *make it more intense*; see Appendix R for the full measure, denoting items included versus omitted). These follow-up items did not contribute to the alcohol expectancy score but were present to balance time due to the additional follow-up questions on SAM use days (see below).

Daily SAM Use. If participants endorsed an alcohol or cannabis expectancy item, they were asked a follow up question to assess SAM expectancies for that item. For AEQ-R (Brown

et al., 1987) items that were endorsed (selecting *Yes, I am expecting this*), participants were asked, "How does marijuana alter this effect?". Response options range from -3 = *make it less intense* to 3 = *make it more intense*. The scale was recoded for analyses as 1-7 by adding a constant of four. Similarly, for MEEQ (Schafer & Brown, 1991) for items that were endorsed (selecting *Yes, I am expecting this*), participants were asked "How does alcohol alter this affect?". Response options and recoding for analyses were the same as for the AEQ-R (Brown et al., 1987) items (i.e., -3 = *make it less intense* to 3 = *make it more intense*; adding a constant of four to recode the scale to 1-7). A higher score would indicate more intense SAM expectancies (i.e., the other substance intensifies the expectancies of the first substance) and a lower score would indicate less intense SAM expectancies (i.e., the other substance does not intensify or lessens the expectancies of the first substance).

Contexts: Environmental and Social

Daily. If participants reported that they used alcohol and/or cannabis the previous day, they were asked to indicate the location(s) where they used the substance(s) from the following list: *own home/apartment/dorm, someone else's home/apartment/dorm, bar/restaurant, outdoor/public place, car or other enclosed motor vehicle,* and *other (please describe)*. Participants were able to select more than one option. Similar locations for alcohol use have been assessed in a sample of young adults (Lipperman-Kreda et al., 2018). I added *car or other enclosed motor vehicle* to the list to reflect an additional location where cannabis use could occur. If participants reported alcohol and/or cannabis use the previous day, they were also asked to indicate if others were present or not (Appendices S, T, & U).

Time Balance Questions

Daily. If substance use was not reported for the previous day, participants were asked questions related to their health and other behaviors to keep the number of questions approximately balanced for time for each day. Some of these questions were also asked of participants who reported only alcohol or cannabis use, or CAM use, to balance for questions about the other substance and/or SAM-specific items. Participants were asked why they did not partake in substance use the previous day, using 22 questions adapted from O'Hara et al.'s (2014) measure and from Heron et al. (2019). O'Hara et al. (2014) developed six reasons as to why people do not drink (e.g., "No desire to drink"), specifically for daily level analysis with a sample of undergraduate students. Five questions related to not drinking were added. Participants selected either true or false for each reason. The same questions were adapted to ask about lack of cannabis use (e.g., "No desire to use marijuana"). Additionally, participants were asked nine questions related to their media use (from Heron et al., 2019), nine questions related to their time management skills (adapted from Bitton & Tesser, 1991), and two questions related to where and on which type of device the participant took the survey (from Heron et al, 2019; Appendix V). A description of the flow of the daily questions depending on type of use day can be found in Appendix D.

Demographics and Contact/Compensation Information

A general questionnaire assessed basic demographic information at baseline, including but not limited to age, student status (i.e., full-time or part-time), class standing, gender, sexual identity, race/ethnicity, marital status, Greek status (member of a fraternity or sorority), and residence (e.g., live on- or off-campus; Appendix W). In addition, participants were asked to provide their name, contact information, time zone, and if they wanted to receive reminders via

text message or email during the daily diary portion of the study (and their phone number and/or email for these reminders). Participants were also asked to provide their Sona ID or email address for compensation (Appendix X).

Attention Checks

Baseline. Four attention checks were included in the baseline survey. Participants were presented with a question that has a correct answer (e.g., "Select the smallest number listed below"; Appendix Y. Those who failed 2 or more attention checks by selecting an incorrect answer were not invited to participate in the daily surveys.

Data Analyses Plan

Analysis Approach

The data collected for this study were multilevel, with data at the daily level (level 1; within subjects) and at the person level (level 2; between subjects), or in other words, days nested within individuals. Multilevel models (MLM) were used so that both within- and between-subjects examinations could be conducted and variables at the person level could be controlled for. All analyses were conducted in HLM (version 8; Scientific Software International, 2020).

Covariates

Based on previous research analyses for SAM use (e.g., Jackson et al., 2020; White et al., 2019), gender and past 30-day alcohol use frequency were covariates for all analyses in the current study. Gender was dummy coded after determining which group was more frequent in the sample. Gender was coded as 0 = *not cisgender men* (included mostly cisgender women and one individual who was not cisgender; reference group) and 1 = *cisgender men* for all proposed analyses.

Centering

All variables at level 1 were person-mean centered and variables at level 2 were grand-mean centered (except for gender). Level-1 variables included in any given analysis were aggregated for analysis at level 2, or the person-level. These variables were aggregated by summing that variable across days in the study for an individual. This allows for between-person examinations of daily variables. These variables were also grand-mean centered, meaning they are interpreted by how much the variables differ from all other participants in the study. Aggregating and grand-mean centering allowed for comparison at the between-person level. The combination of person-mean centering level-1 variables and including their aggregates at level 2 of the analysis allowed for the isolation of within-person effects (via person-mean centered values) from between-person effects (via aggregates).

CHAPTER III

RESULTS

Power Analysis

A power analysis was conducted to determine the appropriate sample size for the study. This occurred in two steps because of the multilevel nature of the data (daily and person-level data). First, G*Power (version 3.1.9.4; Faul et al., 2019) was used to determine how many total participants are needed using a small to medium effect size (f = 0.20). I decided to power for a generic and conservative small to medium effect size because after reviewing the literature, it was determined that the current study's hypotheses are relatively new, and the effect sizes that were available in the literature were fairly large (e.g., Jackson et al., 2020). An ANCOVA analysis (a non-nested or single-level version of the proposed analyses for this project) found that 199 participants are needed for this small to medium effect size, a power of .80, and alpha level of .05. The 199 "participants" are the number of independent observations needed, or $N_{\text{effective}}$ (West et al., 2011). The next step involved using West et al.'s (2011) equation to determine the number of observations needed at Level 1 (daily) for each unit at Level 2 (person) and the number of Level 2 (person) units needed to meet the $N_{\text{effective}}$, taking into account expected degree of variance in the outcome between individuals, also known as the intraclass correlation coefficient (ICC; Raudenbush & Bryk, 2002). The equation follows:

$$N_{effective} = \frac{n_{L1} n_{L2}}{[1 + (n_{L1} - 1)\ \text{ICC}]}$$

$N_{\text{effective}}$ is the total number of "independent" observations needed to power the study, which is 199 (from power analysis in G*Power). To determine the ICC to use for these calculations, previous research was examined for each daily hypothesis and their related outcomes (i.e., expectancies [Butler et al., 2010]; motives [O'Donnell et al., 2019; Patrick et al., 2019];

consequences [Sokolovsky et al., 2020; Stevenson et al., 2019], alcohol quantity [Braitman et al., 2017; Stevenson et al., 2019], cannabis quantity [Gunn et al., 2021]). However, it was decided to use the ICCs from the study that the daily co-use consequences measure was derived from and had a similar population and measure to the current study (i.e., college students; Sokolovsky et al., 2020). The ICCs from this study were 0.15 for the data comparing alcohol-only to co-use daily consequences and 0.18 for comparing cannabis-only to co-use daily consequences (Sokolovsky et al., 2020). A prior daily diary study which recruited participants from the host institution reported a 96.7% compliance rate over 14 days, with 23.5% alcohol use days (Carmichael, 2016). Utilizing this compliance rate and percentage of alcohol use days, it is assumed that for the current study at least 4 out of 21 days for each participant will be substance use days, or useable observations. To determine the number of people needed (n_{l2}), the expected number of use days (n_{l1} = 4), $N_{\text{effective}}$ (199), and ICCs (.15 and .18) were plugged into the West et al. (2011) equation. These analyses determined that 75 participants (n_{l2}) would be needed to have sufficient power for the study. Because of limitations in recruitment of participants for this study, the number of participants needed to have sufficient power for the study was not reached. Although recruitment was expanded in several ways (i.e., offering monetary compensation to recruit outside of the Sona pool, expanding to recruiting at three additional local academic institutions), only N = 18 participants are included in the final sample. This severely hinders power.

Data Cleaning and Assumption Checks

Analyses were conducted in SPSS 25 and HLM 8 (Scientific Software International, 2020). Multilevel analyses are robust to missing observations, which would be days skipped for this study. Due to the complexity of conducting imputation for multilevel analyses, pairwise

deletion was conducted. There were no missing data at baseline for gender or past 30-day alcohol frequency. Participants completed a range of daily surveys from 3-21 (*M* = 14.56), with 108 alcohol only use days, 98 cannabis only use days, 60 SAM use days, 8 CAM use days, and 56 no substance use days. At the daily level, three participants reported neither SAM nor CAM use days, thus were not included in Aim 2 analyses.

Assumptions of MLM were checked. Normality of the data for continuous variables were assessed using histograms, skewness, and kurtosis statistics. Outliers were assessed using boxplots. Daily alcohol quantity was skewed (2.67) and kurtotic (7.86). There were six outliers (three times the interquartile range), which were winsorized (rank was maintained). After winsorizing the data, daily alcohol quantity was normally distributed (skew = 1.73, kurtosis = 2.69). The remaining variables were normally distributed. Study variable descriptives can be seen in Table 2.

Throughout the study period, participants consumed an average of 3.63 standard drinks of alcohol (*SD* = 2.92) across all types of alcohol on days when alcohol was consumed, and 0.79 grams (*SD* = 0.77) of cannabis across all routes of administration on days when cannabis was used. Participants reported an average of 0.78 consequences (*SD* = 1.18) on either CAM (*M* = 0.38, *SD* = 0.74) or SAM use days (*M* = 0.83, *SD* = 1.22).

On co-use days, social (80.9%) and enhancement (85.3%) were the most frequently endorsed alcohol motives, whereas celebration (40.9%) and enjoyment (97%) were the most frequently endorsed cannabis motives. On SAM use days, participants endorsed the SAM motives of positive effects – alcohol (71.7%), positive effects – cannabis (60.3%), calm/coping (42.4%) and social (61.0%); participants did not endorse the conformity SAM motive.

Participants reported being in their own home/apartment/dorm most often for either SAM or CAM use days (54.4% of days). Additionally, participants reported that others were present 67.6% of the time for either SAM or CAM use days. On SAM use days specifically, participants reported that others were present 75% of the time.

Table 2

Descriptive Information for Daily Study Variables

Study Variables	*M* (*SD*)		
Number of standard drinks (all days)	3.63 (2.92)		
Grams of cannabis (all days)	0.79 (0.77)		
	Co-use days (*n* = 68)	SAM days (*n* = 60)	CAM days (*n* = 8)
Consequences	0.78 (1.18)	0.83 (1.22)	0.38 (0.74)
Alcohol expectancies	2.33 (0.92)	2.14 (1.03)	2.80 (.45)
Cannabis expectancies	1.96 (0.99)	1.86 (0.95)	1.40 (1.14)
SAM expectancies	-	5.40 (1.06)	-
	Co-use days (*n* = 68)	SAM days (*n* = 60)	CAM days (*n* = 8)
	n (%)	*n* (%)	*n* (%)
Motives			
Coping-anxiety alcohol motive	23 (34.3%)	19 (32.2%)	4 (50.0%)
Coping-depression alcohol motive	15 (22.4%)	13 (22.0%)	2 (25.0%)
Social alcohol motive	55 (80.9%)	50 (83.3%)	5 (62.5%)
Enhancement alcohol motive	58 (85.3%)	52 (86.7%)	6 (75.0%)
Conformity alcohol motive	3 (4.4%)	2 (3.3%)	1 (12.5%)
Conformity cannabis motive	3 (4.5%)	2 (3.3%)	1 (12.5%)
Availability/boredom cannabis motive	11 (16.4%)	11 (18.3%)	0 (0.0%)
Celebration cannabis motive	27 (40.9%)	26 (43.3%)	1 (12.5%)
Coping cannabis motive	13 (19.7%)	11 (18.3%)	2 (25.0%)
Enjoyment cannabis motive	65 (97.0%)	57 (95.0 %)	8 (100.0%)
Positive effects-alcohol motive	-	43 (71.7%)	-
Positive effects-cannabis motive	-	35 (60.3%)	-
Calm/coping motive	-	25 (42.4%)	-
Social motive	-	36 (61.0%)	-
Conformity motive	-	0 (0%)	-
Context			
Own home/apartment/dorm	37 (54.4%)	34 (56.7%)	3 (37.5%)
Someone else's home/apartment/dorm	13 (19.1%)	13 (21.7%)	0 (0.0%)
Multiple locations	11 (16.2%)	11 (18.3%)	0 (0.0%)
Bar/restaurant	4 (5.9%)	0 (0.0%)	4 (50.0%)
Outdoor/public space	2 (2.9%)	2 (3.3%)	0 (0.0%)
Enclosed motor vehicle	1 (1.5%)	0 (0.0%)	1 (12.5%)
Others were present	46 (67.6%)	45 (75.0%)	7 (87.5%)

Random vs. Fixed Effects for MLM Analyses.

To determine if level-1 predictors (e.g., type of use day) should be random or fixed effects, chi-square statistics were calculated to compare the fit of models with effects specified as random versus fixed (Snijders & Bosker, 2012). First, analyses were conducted specifying both the fixed effect (one model) and random effect (a separate model). The deviance statistics and degrees of freedom for the model were provided by the software. The difference between the deviance statistics and degrees of freedom were calculated, which then were used to calculate the chi-square probability. If this probability was less than .05, random effects were used. If it was greater than or equal to .05, then the model fit is not significantly better with the random effect, so the fixed effect was used (Snijders & Bosker, 2012). All final models in the current examination used fixed effects.

Variability in Study Outcomes

Intraclass correlations (ICCs) were calculated for continuous outcome variables to determine how much variability is explained by within-person rather than between-person changes over the study (21 days). ICCs cannot be accurately calculated for categorical outcome variables (Raykov & Marcoulides, 2015). Within-person variability (1 - ICC) ranged from 29%-38%. See Table 3 for all ICCs calculated.

Table 3

Intraclass Correlation Coefficients for Daily Continuous Outcome Variables

	σ^2	τ	ICC
Alcohol quantity	3.73	6.12	0.62
Cannabis quantity	0.18	0.39	0.69
Co-use consequences	0.55	1.10	0.67
SAM consequences	0.51	1.31	0.72
Co-use alcohol expectancies	0.31	0.80	0.72
Co-use cannabis expectancies	0.24	0.60	0.71
SAM expectancies	0.12	1.62	0.93

Statistical Analyses for Study Aims

Aim 1

To identify the most common type of alcohol and route of cannabis administration used by college students when using the substances on their own (Research question 1.1 and Research question 1.2), frequencies and percentages for each substance were calculated. Type of alcohol had eight levels: beer (*n* = 10; 9.5% of alcohol days), hard cider (*n* = 1; 1.0%), wine (*n* = 14; 13.3%), mixed drinks (un-caffeinated; *n* = 21; 20.0%), mixed drinks (caffeinated; *n* = 2; 1.9%), hard seltzer (*n* = 17; 16.2%), shots (liquor; *n* = 8; 7.6%), and multiple drink types (*n* = 32; 30.5%). Route of cannabis administration has four levels: plant (smoking; *n* = 122; 73.5% of cannabis days), edibles (*n* = 7; 4.2%), concentrates (*n* = 22; 13.3%), and multiple routes of cannabis administration (*n* = 15; 9.0%). Topicals as a route of cannabis administration was not endorsed by participants on any study day. The results of these analyses were used to dummy code type of alcohol and route of cannabis administration for subsequent analyses (unless otherwise specified), with the most frequently used for each being coded as the reference group.

The MLM analyses for Aim 1 at the daily level examined within-person differences at level 1, as well as aggregated at level 2 to examine between-person differences. Two multinomial MLM analyses examined if the likelihood of type of alcohol (eight types) and route of cannabis administration (four types) were different on days when using the substances concurrently, simultaneously, or on their own (Research question 1.3; level 1). For the first set of analyses at the daily level, type of day was dummy coded differently for the analyses focused on days alcohol was used, and for the analyses focused on days cannabis was used. For both sets of analyses, type of day was represented with two variables: for days alcohol was consumed, the variables represented if it was a CAM day (1 = *CAM use day*, 0 = *not a CAM day*) or if it was a SAM day (1 = *SAM use day*, 0 = *not a SAM day*). So for the *CAM day* and *SAM day* variables,

alcohol only days served as the category of reference (was coded as 0, 0), CAM days were coded as (1, 0), and SAM days were coded as (0, 1). Similarly, for days cannabis was used, the variables represented if it was a CAM day (1 = *CAM use day*, 0 = *not a CAM day*) or if it was a SAM day (1 = *SAM use day*, 0 = *not a SAM day*). So for the *CAM day* and *SAM day* variables, cannabis only days served as the category of reference (were coded as 0, 0), CAM days were coded as (1, 0), and SAM days were coded as (0, 1). At the aggregate level, type of day represented the proportion of CAM use days or SAM use days out of all days alcohol or cannabis was used, depending on the analysis. The analytic sample was narrowed to days when alcohol was used (alone or with cannabis) in one set of analyses, and days when cannabis was used (alone or with alcohol) in the second set of analyses. As the outcome is multinomial, there was a series of outcomes, comparing each type of alcohol and route of cannabis administration to the reference group. The reference group for each analysis was decided after determining which type of alcohol and route of cannabis administration is the most frequently used (see above). An example equation for alcohol (specifically beer, with multiple alcohol types as the reference group) is shown below:

$$\text{Level 1 model: Prob}[alcohol\_beer = 1 | \pi_1] = \phi_{1ti}$$

$$\log[\phi_{1ti}/\phi_{8ti}] = \pi_{0i(1)} + \pi_{1i(1)}(\text{SAM\_use\_day}_{ti}) + \pi_{2i(1)}(\text{CAM\_use\_day}_{ti}) + e_{ti}$$

$$\text{Level 2 model: } \pi_{0i(1)} = \beta_{00(1)} + \beta_{01(1)}(\text{SAM\_use\_day\_agg}_i) + \beta_{02(1)}(\text{CAM\_use\_day\_agg}_i) +$$

$$\beta_{03(1)}(\text{gender}_i) + \beta_{04(1)}(\text{alcohol\_30}_i) + r_{0i}$$

$$\pi_{1i(1)} = \beta_{10(1)}$$

$$\pi_{2i(1)} = \beta_{20(1)}$$

The outcome for the level 1 equation is the likelihood of an individual consuming beer rather than multiple types of alcohol on any alcohol use day. $\pi_{0i(1)}$ in the level 1 equation is the intercept for an individual *i* (also the outcome in the level 2 equation), which represents the likelihood of an individual consuming beer rather than multiple types of alcohol when all predictors (i.e., SAM_use_day$_{ti}$ and CAM_use_day$_{ti}$) are both at zero, which would be alcohol-only use days. The subscript 1 in parentheses refers to this as the first intercept (for beer), with additional intercepts to be estimated in separate equations for other forms of alcohol (2 through 7 reflecting each type being compared to multiple types of alcohol). $\pi_{1i(1)}$ is the slope for the relationship between beer and SAM use days, or how the likelihood of consuming beer compared to multiple types of alcohol changes for a SAM use day compared to an alcohol-only day. Positive values would reflect that the likelihood of participants drinking beer increases on SAM use days compared to alcohol-only days, whereas negative values would reflect that the likelihood of drinking beer decreases on SAM use days compared to alcohol-only days; this is the within-person effect of SAM use. $\pi_{2i(1)}$ is the slope for the relationship between beer and CAM use days, or how the likelihood for consuming beer compared to multiple types of alcohol changes for a CAM use day compared to an alcohol-only day. Positive values would reflect that the likelihood of participants drinking beer increases on CAM use days compared to alcohol-only days, whereas negative values would reflect that the likelihood of drinking beer decreases on CAM use days compared to alcohol-only days; this is the within-person effect of CAM use. At Level 2, $\beta_{00(1)}$ is the intercept of the sample, reflecting the expected likelihood when all predictors are zero, or the grand mean of the likelihoods for beer on alcohol-only days for not cisgender men and average past 30-day alcohol frequency. $\beta_{01(1)}$ is the slope for the relationship between type of alcohol consumed (i.e., likelihood of beer) and proportion of SAM use days

(i.e., $SAM\_use\_day\_agg_i = 1$), or how the likelihood of beer consumption changes for individuals with greater proportions of SAM use days. Positive values would reflect that participants who engage in SAM use more often are also more likely to drink beer regularly whereas negative values would reflect that participants who engage in SAM use more often are less likely to drink beer regularly; this is the between-person effect of SAM use. $\beta_{02(1)}$ is the slope for the relationship between type of alcohol consumed and proportion of CAM use days (i.e., $CAM\_use\_day\_agg_i = 1$), or how the likelihood of beer consumption changes for individuals with higher proportions of CAM use days. Positive values would reflect that participants who engage in CAM use more often are also more likely to drink beer regularly whereas negative values would reflect that participants who engage in CAM use more often are less likely to drink beer regularly; this is the between-person effect of CAM use. $\beta_{03(1)}$ and $\beta_{04(1)}$ represent the covariates (gender and past 30-day alcohol frequency, respectively), and are the slopes for the relationships between each covariate and likelihood of beer consumption, or how the likelihood of drinking beer changes for cisgender men and individuals with more frequent alcohol consumption, respectively. The residual r_{0i} is the difference between the predicted likelihood of beer consumption (intercept) for the overall sample, and the predicted likelihood of beer consumption (intercept) for each specific individual. All parameter estimates include the subscript 1 in parentheses to indicate the equations reflect reporting consuming beer (rather than multiple types of alcohol). This series of equations is repeated for each type of alcohol (except multiple types of alcohol) reflecting the likelihood of consuming that alcohol type (as opposed to multiple types of alcohol), but are all conducted simultaneously as a single analysis.

This analysis did not run correctly. This is likely because three groups (alcohol only days, SAM days, and CAM days) are being compared across eight alcohol types with a small sample

size, likely leaving many cells/combinations that were either empty or had very low endorsement (e.g., there were no CAM days where beer, hard cider, or wine were used).

An example equation for cannabis (specifically edibles, with plant as the reference group) is shown below:

$$\text{Level 1 model: Prob}[\textit{edibles} = 1 | \pi_1] = \phi_{1ti}$$

$$\log[\phi_{1ti}/\phi_{4ti}] = \pi_{0i(1)} + \pi_{1i(1)}(\text{SAM\_use\_day}_{ti}) + \pi_{2i(1)}(\text{CAM\_use\_day}_{ti}) + e_{ti}$$

$$\text{Level 2 model: } \pi_{0i(1)} = \beta_{00(1)} + \beta_{01(1)}(\text{SAM\_use\_day\_agg}_i) + \beta_{02(1)}(\text{CAM\_use\_day\_agg}_i) +$$

$$\beta_{03(1)}(\text{gender}_i) + \beta_{04(1)}(\text{alcohol\_30}_i) + r_{0i(1)}$$

$$\pi_{1i(1)} = \beta_{10(1)}$$

$$\pi_{2i(1)} = \beta_{20(1)}$$

The outcome for the level 1 equation is the likelihood of an individual using cannabis edibles rather than cannabis plant on any cannabis use day. π_{0i} in the level 1 equation is the intercept for an individual *i* (also the outcome in the level 2 equation), which represents the likelihood of an individual using cannabis edibles rather than cannabis plant when all predictors (i.e., SAM_use_day_{ti} and CAM_use_day_{ti}) are at zero, which would be cannabis-only use days. The subscript 1 in parentheses refers to this as the first intercept (for cannabis concentrate), with additional intercepts to be estimated in separate equations for other forms of cannabis (2 through 34 reflecting each type being compared to cannabis plant). $\pi_{1i(1)}$ is the slope for the relationship between cannabis edibles and SAM use days, or how the likelihood for using cannabis edibles compared to cannabis plant changes for a SAM use day compared to an cannabis-only day. Positive values would reflect that the likelihood of participants using cannabis edibles increases on SAM use days compared to cannabis-only days, whereas negative values would reflect that

the likelihood of using cannabis edibles decreases on SAM use days compared to cannabis-only days; this is the within-person effect of SAM use. $\pi_{2i(1)}$ is the slope for the relationship between cannabis edibles and CAM use days, or how the likelihood for using cannabis edibles compared to cannabis plants changes for a CAM use day compared to a cannabis-only day. Positive values would reflect that the likelihood of participants using cannabis edibles increases on CAM use days compared to cannabis-only days, whereas negative values would reflect that the likelihood of using cannabis edibles decreases on CAM use days compared to cannabis-only days; this is the within-person effect of CAM use. At Level 2, $\beta_{00(1)}$ is the intercept of the sample, reflecting the expected likelihood when all predictors are zero, or the grand mean of the likelihoods for cannabis edibles on cannabis-only days for not cisgender men and average past 30-day alcohol frequency. $\beta_{01(1)\text{ is}}$ the slope for the relationship between route of cannabis administration used (i.e., likelihood of cannabis edibles) and proportion of SAM use days (i.e., $SAM\_use\_day\_agg_i$ = 1), or how the likelihood of cannabis edibles us changes for individuals with greater proportions of SAM use days. Positive values would reflect that participants who engage in SAM use more often are also more likely to use cannabis edibles regularly whereas negative values would reflect that participants who engage in SAM use more often are less likely to use cannabis edibles regularly; this is the between-person effect of SAM use. $\beta_{02(1)}$ is the slope for the relationship between route of cannabis administration used and proportion of CAM use days (i.e., $CAM\_use\_day\_agg_i$ = 1), or how the likelihood for cannabis edibles use changes for individuals with higher proportions of CAM use days. Positive values would reflect that participants who engage in CAM use more often are also more likely to use cannabis edibles regularly whereas negative values would reflect that participants who engage in CAM use more often are less likely to use cannabis edibles regularly; this is the between-person effect of CAM

use. $\beta_{03(1)}$ and $\beta_{04(1)}$ represent the covariates (gender and past 30-day alcohol frequency, respectively), and are the slopes for the relationships between each covariate and likelihood of cannabis edibles use, or how the likelihood of using cannabis edibles changes for not cisgender men and individuals with more frequent alcohol consumption, respectively. The residual r_{0i} is the difference between the predicted likelihood of cannabis edibles use (intercept) for the overall sample, and the predicted likelihood of cannabis edibles use (intercept) for each specific individual. All parameter estimates include the subscript 1 in parentheses to indicate the equations reflect reporting using cannabis edibles (rather than cannabis plant). As with the previous example, this series of equations is repeated for each route of cannabis administration (except cannabis plant), reflecting the likelihood of consuming that route of cannabis administration (as opposed to cannabis plant), but are all conducted simultaneously as a single analysis.

Similar to the alcohol examination, this analysis for routes of cannabis administration did not run correctly. This could be because three groups (alcohol only days, SAM days, and CAM days) are being compared across four routes of cannabis administration with a small sample size, likely leaving many cells/combinations that were either empty or had very low endorsement (e.g., there were no CAM days where edibles or concentrates was used).

MLM analyses examined if the amount of alcohol consumed varied by types of alcohol consumed on any alcohol-use day (Research question 1.4; level 1). A similar analysis examined if amount of cannabis used varied by route of cannabis administration on any cannabis-use day (Research question 1.5; level 1). The reference group for each of these analyses was the type of alcohol and route of cannabis administration most frequently used (see Research question 1.1.

and 1.2 above). The equation for type of alcohol (with multiple alcohol types as the reference group) and alcohol quantity is shown below (Research question 1.4):

$$\text{Level 1 model: } alcohol\_quant_{ti} = \pi_{0i} + \pi_{1i}(beer_{ti}) + \pi_{2i}(hard\_cider_{ti}) + \pi_{3i}(wine_{ti}) + \pi_{4i}(hard\_seltzer_{ti}) + \pi_{5i}(shots_{ti}) + \pi_{6i}(smixed\_drinks\_caf_{ti}) + \pi_{7i}(mixed\_drinks\_uncaf_{ti}) + e_{ti}$$

$$\text{Level 2 model: } \pi_{0i} = \beta_{00} + \beta_{01}(beer\_agg_i) + \beta_{02}(hard\_cider\_agg_i) + \beta_{03}(wine\_agg_i) + \beta_{04}(hard\_seltzer\_agg_i) + \beta_{05}(shots\_agg_i) + \beta_{06}(mixed\_drinks\_caf\_agg_i) + \beta_{07}(mixed\_drinks\_uncaf\_agg_i) + \beta_{08}(gender) + \beta_{09}(alcohol\_30) + r_{0i}$$

$$\pi_{1i} = \beta_{10}$$

$$\pi_{2i} = \beta_{20}$$

$$\pi_{3i} = \beta_{30}$$

$$\pi_{4i} = \beta_{40}$$

$$\pi_{5i} = \beta_{50}$$

$$\pi_{6i} = \beta_{60}$$

$$\pi_{7i} = \beta_{70}$$

The outcome for the level 1 equation is the amount of alcohol consumed (in standard drinks) reported by individual *i* on that day (time *t*). π_{0i} in the level 1 equation (also the outcome in the level 2 equation) is the intercept for individual *i*, which represents the reported amount of alcohol consumed by an individual when all predictors (e.g., $beer_{ti}$) are at zero, which is multiple alcohol types. Π_{1i}, $\pi_{2i,}$ $\pi_{3i,}$ $\pi_{4,}$ $\pi_{5i,}$ $\pi_{6i,}$ and π_{7i} represent how the total reported alcohol quantity consumed changes for each type of alcohol (beer, hard cider, wine, hard seltzer, shots [liquor], mixed drinks caffeinated, and mixed drinks caffeinated, respectively). The residual e_{ti} is the difference between the predicted total number of standard drinks consumed and the actual total number of standard drinks reported by an individual. At level 2, β_{00} is the grand intercept of the

sample, or the expected total alcohol quantity consumed when all predictors (e.g., beer_agg$_i$) are at zero, which would be for average multiple types of alcohol consumed, not cisgender men, and average past 30-day alcohol frequency in the sample. $\beta_{01,}$ $\beta_{01,}$ $\beta_{02,}$ $\beta_{03,}$ $\beta_{04,}$ $\beta_{05,}$ β_{06} and β_{07} represent how the total alcohol quantity consumed reported changes for individuals who consume beer, hard cider, wine, hard seltzer, shots [liquor], mixed drinks caffeinated, and mixed drinks caffeinated more during the study period (e.g., beer_agg$_i$ increases). B_{08} and β_{09} represent the effects of covariates (gender and past 30-day alcohol frequency, respectively), and are the slopes for the relationships between total alcohol quantity consumed and covariates for the sample, or how total alcohol quantity consumed changes for cisgender men, more frequent alcohol consumption, respectively. The residual r_{0i} is the difference between the total alcohol quantity consumed intercept for an individual and the expected value from the model.

As seen in Table 4 there was a significant difference between days when multiple types of alcohol were consumed and shots (liquor), such that participants consumed 3.02 more standard drinks on days they consumed shots (liquor; $p < 0.001$). Additionally, there was a significant difference between days when multiple types of alcohol were consumed and mixed drinks caffeinated, such that participants consumed 2.16 more standard drinks on days they consumed caffeinated mixed drinks ($p = 0.035$). No other types of alcohol were significantly different from days when multiple types of alcohol were consumed in regards to quantity of alcohol consumed. Regarding person-level effects, there were no significant differences between participants who consumed more multiple types of alcohol during the study period and other types of alcohol.

Table 4

Multilevel Model of Type of Alcohol Predicting Number of Standard Drinks Consumed

	B (*SE*)	*p*
Intercept	3.07** (0.72)	.003
Level 1: Day level		
Beer	-0.09 (0.64)	.890
Hard cider	0.83 (0.94)	.380
Wine	-0.08 (0.74)	.915
Hard seltzer	1.28 (0.72)	.079
Shots (liquor)	3.02*** (0.48)	<.001
Caffeinated mixed drinks	2.16* (1.01)	.035
Un-caffeinated mixed drinks	1.04 (0.58)	.080
Level 2: Person level		
Beer - aggregated	4.56 (2.65)	.124
Hard cider - aggregated	4.38 (9.41)	.654
Wine – aggregated	3.82 (2.16)	.114
Hard seltzer – aggregated	3.20 (2.14)	.173
Shots (liquor) – aggregated	2.97 (2.26)	.225
Caffeinated mixed drinks – aggregated	1.81 (4.18)	.676
Un-caffeinated mixed drinks – aggregated	2.81 (2.56)	.304
Past 30-day alcohol quantity- aggregated	0.03 (0.09)	.780
Gender	2.12 (1.76)	.264

*$p < .05$. **$p < .01$. ***$p < .001$.

The equation for the route of cannabis administration (with plant as the reference group) and cannabis quantity is shown below (Research question 1.5):

$$\text{Level 1 model: } \text{cannabis\_quant}_{ti} = \pi_{0i} + \pi_{1i}(\text{edibles}_{ti}) + \pi_{2i}(\text{concentrates}_{ti}) + \pi_{3i}(\text{multiple\_routes}_{ti}) + e_{ti}$$

$$\text{Level 2 model: } \pi_{0i} = \beta_{00} + \beta_{01}(\text{edibles\_agg}_i) + \beta_{02}(\text{concentrates\_agg}_i) + \beta_{03}(\text{multiple\_agg}_i) + \beta_{04}(\text{gender}_i) + \beta_{05}(\text{alcohol\_30}_i) + r_{0i}$$

$$\pi_{1i} = \beta_{10}$$

$$\pi_{2i} = \beta_{20}$$

$$\pi_{3i} = \beta_{30}$$

The outcome for the level 1 equation is the amount of cannabis used (in grams) reported by an individual *i* on that day (time *t*). π_{0i} in the level 1 equation (also the outcome in the level 2 equation) is the intercept for individual *i*, which represents the total amount of cannabis used reported for an individual when all predictors (e.g., edibles_{ti}) are at zero, which would be for plant. π_{1i}, $\pi_{2i,}$ $\pi_{3i,}$ represent how the total reported amount of cannabis used changes for each route of cannabis administration (edibles, concentrates, and multiple routes, respectively). The residual e_{ti} is the difference between the predicted total amount of cannabis used and the actual total amount of cannabis used reported by an individual. At level 2, β_{00} is the grand intercept of the sample, or the expected total amount of cannabis used when all predictors (e.g., edibles_agg_i) are at zero, which would be for average concentrates used, not cisgender men, average past 30-day alcohol frequency, and average past 30-day cannabis frequency. $\beta_{01,}$ $\beta_{02,}$ and β_{03} represent how the total reported amount of cannabis used changes for individuals who use edibles, concentrates, and multiple routes of administration more frequently during the study period (e.g., edibles_agg_i increases). β_{04} and β_{05} represent the effects of covariates (gender and past 30-day alcohol

frequency, respectively), and are the slopes for the relationships between total amount of cannabis used and covariates for the sample, or how total amount of cannabis used change for cisgender men and more frequent alcohol consumption, respectively. The residual r_{0i} is the difference between the total amount of cannabis used intercept for an individual and the expected value from the model.

As seen in Table 5, compared to days when participants used plant as a route of cannabis administration, there was a non-significant trend for participants to use more grams of edibles, less grams concentrates, and more grams of multiple routes of cannabis administration. Regarding person-level effects, there was a significant difference between participants who used plant more frequently as a route of administration during the study period and those that used more frequently used multiple routes of cannabis administration, such that those who more frequently used multiple routes of cannabis administration used 3.14 more grams of cannabis per occasion than those who used plant more frequently as a route of cannabis administration (p = .015). There were not significant differences in amount of cannabis used between participants e who used plant more frequently as a route of cannabis administration during the study period compared to those who used edibles and concentrates more frequently.

Table 5

Multilevel Model of Route of Cannabis Administration Predicting Amount of Cannabis Consumed on Cannabis Use Days

	B (*SE*)	*p*
Intercept	0.73** (0.18)	.002
Level 1: Day level		
Edibles	0.004 (0.22)	.986
Concentrates	-0.23 (0.16)	.160
Multiple Routes of Administration	0.29 (0.19)	.123
Level 2: Person level		
Edibles - aggregated	-0.84 (0.71)	.257
Concentrates - aggregated	-0.45 (0.48)	.369
Multiple routes of administration – aggregated	3.14* (1.09)	.015
Past 30-day alcohol quantity- aggregated	-0.01 (0.02)	.566
Gender	0.03 (0.34)	.935

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

Aim 2

All analyses for Aim 2 examined within-person differences at level 1 as well as between-person differences at level 2. Note that the analytic sample was narrowed to only days where both alcohol and cannabis were used (SAM and CAM days; $n = 68$) to facilitate a comparison where the substances used were the same, but the main difference is that their effects do or do not overlap. Type of day was dummy coded as 0 = *SAM use days* (reference group) and 1 = *CAM use days*.

Consequences. MLM analyses examined if more consequences are reported on SAM use days versus CAM use days (Hypothesis 2.1; level 1). The analysis was first conducted without controlling for past 30-day frequency of alcohol. Then, it was conducted controlling for frequency of use to determine if consequences are attributable to type of use day above and beyond the effects of past 30-day frequency of use. The following model includes past 30-day frequency of use as a covariate:

$$\text{Level 1 model: } \text{Conseq\_tot}_{ti} = \pi_{0i} + \pi_{1i}(\text{type\_of\_use\_day}_{ti}) + e_{ti}$$

$$\text{Level 2 model: } \pi_{0i} = \beta_{00} + \beta_{01}(\text{type\_of\_use\_day\_agg}_{i}) + \beta_{02}(\text{gender}_{i}) + \beta_{03}(\text{alcohol\_30}_{i}) + r_{0i}$$

$$\pi_{1i} = \beta_{10}$$

The outcome for the level 1 equation is total consequences reported by individual *i* on that day (time *t*). π_{0i} in the level 1 equation (also the outcome in the level 2 equation) is the intercept for individual *i*, which represents the total number of consequences reported for an individual when all predictors (i.e., $\text{type\_of\_use\_day}_{ti}$) are at zero, which would be SAM use days. π_{1i} represents how total consequences reported changes for CAM use days (i.e., $\text{type\_of\_use\_day}_{ti} = 1$). The residual e_{ti} is the difference between the predicted total consequences reported and the actual total consequences reported by an individual. At Level 2,

β_{00} is the grand intercept of the sample, or the expected total consequences when all level-2 predictors (e.g., type_of_use_day_agg$_i$) are at zero, which would be for average frequency of SAM use days, not cisgender men, and average past 30-day alcohol frequency. β_{01} represents how the expected number of consequences changes for individuals with more CAM use days during the study period (i.e., type_of_use_day_agg$_i$ increases). β_{02} and β_{03} represent the effects of covariates (gender and past 30-day alcohol frequency, respectively), and are the slopes for the relationships between the total consequences and the covariates for the sample, or how the expected number of consequences changes for cisgender men and more frequent alcohol consumption, respectively. The residual r_{0i} is the difference between the total consequences intercept for an individual and the expected value from the model.

After running both models (with and without past 30-day alcohol frequency), it was determined that past 30-day alcohol frequency did not need to be controlled for in the analyses, as the association between consequences and type of use day was significant for both models (See Table 6). Participants reported significantly fewer consequences on CAM use days than SAM use days (0.76 less; p = .026). Number of co-use consequences reported was not significantly associated with proportion of CAM use days during the study period.

Table 6

Multilevel Model of Type of Co-Use Day Predicting Number of Consequences Reported

	Controlling for past 30-day alcohol frequency		Not controlling for past 30-day alcohol frequency)	
	B (*SE*)	*p*	*B* (*SE*)	*p*
Intercept	0.51 (0.30)	.113	0.54 (0.31)	.104
Level 1: Day level				
Type of use day (i.e., CAM days)	-0.76* (0.33)	.026	-0.76* (0.33)	.026
Level 2: Person level				
Type of use day_aggregated (i.e., CAM days)	-0.33 (1.26)	.795	-0.86 (1.23)	.497
Past 30-day alcohol quantity- aggregated	0.05 (0.04)	.206	-	-
Gender	1.35* (0.53)	.028	1.29* (0.54)	.035

*$p < .05$.

Motives. Ten binomial MLM analyses were conducted to examine if alcohol- (5 models) and cannabis-related motives (5 models) vary between SAM and CAM use days (Research question 2.1; level 1), one for each type of alcohol-related motives and one for each type of cannabis-related motives. An example equation is shown below:

$$\text{Level 1 model: Prob[Alc\_motive\_social=1}|\,\pi_1] =$$

$$\phi_{1ti}$$

$$\log[\phi_{1ti}/\,\phi_{2ti}] = \pi_{0i(1)} + \pi_{1i(1)}(\text{type\_of\_use\_day}_{ti}) + e_{ti}$$

$$\text{Level 2 model: } \pi_{0i} = \beta_{00(1)} + \beta_{01(1)}(\text{type\_of\_use\_day\_agg}_i) + \beta_{02(1)}(\text{gender}_i) + \beta_{03(1)}(\text{alcohol\_30}_i) +$$

$$r_{0i}$$

$$\pi_{1i(1)} = \beta_{10(1)}$$

The outcome for the level 1 equation is the likelihood of an individual reporting the social alcohol motive on any alcohol and cannabis use day. π_{0i} in the level 1 equation (also the outcome in the level 2 equation) is the intercept for individual *i*, which represents the likelihood of an individual reporting experiencing a social alcohol motive when all predictors (i.e., $\text{type\_of\_use\_day}_{ti}$) are at zero, which would be SAM use days. π_{1i} is the slope for the relationship between reporting a social alcohol motive and CAM use days, or how the likelihood for reporting a social alcohol motive changes for CAM use days (compared to SAM use days). Positive values would reflect that the likelihood of participants reporting a social alcohol motive increases on CAM use days compared to SAM use days, whereas negative values would reflect that the likelihood of reporting a social alcohol motive decreases on CAM use days compared to SAM use days; this is the within-person effect of CAM use. At Level 2, $\beta_{00(1)}$ is the grand intercept, reflecting the expected likelihood when all predictors (e.g., $\text{type\_of \_use\_day\_agg}_{i,}$) are at zero, which would be for the grand mean for SAM use days, not cisgender men, and

average past 30-day alcohol frequency. $\beta_{01(1)}$ is the slope for the relationship between reporting experiencing a social alcohol motive and proportion of CAM use days (i.e., $type\_of\_use\_day\_agg_i = 1$), or how the likelihood of reporting experiencing a social alcohol motive changes for individuals with greater proportions of CAM days. Positive values would reflect that participants who engage in CAM use more often are also more likely to report a social alcohol motive whereas negative values would reflect that participants who engage in CAM use more often are less likely to report a social alcohol motive regularly; this is the between-person effect of CAM use. $\beta_{02(1)}$ and $\beta_{03(1)}$ represent the covariates (gender and past 30-day alcohol frequency, respectively), and are the slopes for the relationships between each covariate and the likelihood of reporting a social alcohol motive, or how the likelihood of reporting a social alcohol motive changes for cisgender men and individuals with more frequent alcohol consumption, respectively. The residual r_{0i} is the difference between the predicted likelihood of reporting a social alcohol motive (intercept) for the overall sample, and the predicted likelihood of reporting a social alcohol motive (intercept) for each specific individual.

As seen in Table 7, the likelihood of an individual reporting any type of alcohol motive (i.e., coping-anxiety, coping-depression, social, enhancement, and conformity) was not significantly different for a CAM use day compared to a SAM use day

Table 7

Multilevel Model of Co-Use Days Predicting Alcohol Motives

	Coping-anxiety			Coping-depression			Social			Enhancement			Conformity		
	B (*SE*)	*p*	OR [CI]	*B* (*SE*)	*p*	OR [CI]	*B* (*SE*)	*p*	OR [CI]	*B* (*SE*)	*p*	OR [CI]	*B* (*SE*)	*p*	OR [CI]
Intercept	-1.14 (0.82)	.190	0.32 [0.05, 1.93]	-2.55* (0.90)	.017	0.08 [0.01, .057]	1.67* (0.62)	.021	5.31 [1.36, 20.68]	1.80* (0.59)	.011	6.03 [1.65, 21.99]	-3.61** (0.94)	.003	0.03 [0.003, 0.21]
Level 1: Day level															
Type of use day (i.e., CAM days)	-1.24 (1.53)	.422	0.29 [0.01, 6.30]	0.00 (2.05)	1.000	1.00 [0.02, 61.58]	-1.20 (1.13)	.294	0.30 [0.03, 2.30]	-1.15 (1.34)	.395	0.32 [0.02, 4.66]	0.00 (1.56)	1.000	1.00 [0.04, 22.80]
Level 2: Person level															
Type of use day_aggregated (i.e., CAM days)	5.52 (3.59)	.152	249.60 [0.09, 672218.57]	-0.71 (4.56)	.880	0.49 [0.00, 11293.41]	-2.33 (2.52)	.376	.10 [0.00, 25.12]	-2.45 (2.63)	.371	0.09 [0.00, 28.14]	4.85 (2.92)	.125	127.91 [0.21, 79322.32]
Past 30-day alcohol frequency	-0.01 (0.11)	.950	0.99 [0.78, 1.27]	0.12 (0.10)	.256	1.13 [0.90, 1.43]	-0.05 (0.08)	.516	0.95 [0.80, 1.13]	-0.088 (0.08)	.317	0.92 [0.77, 1.10]	0.04 (0.12)	.753	1.04 [0.80, 1.35]
Gender	0.21 (1.47)	.887	1.24 [0.05, 31.67]	2.15 (1.50)	.178	8.62 [0.32, 233.38]	0.06 (1.13)	.959	1.06 [0.09, 12.75]	1.28 (1.35)	.364	3.60 [0.18, 70.68]	0.31 (1.35)	.822	1.37 [0.07, 26.65]

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

Regarding person-level effects, the likelihood of reporting any type of alcohol motive was not significantly different between individuals with a greater proportion of CAM use days than individuals with a greater proportion of SAM use days during the study period.

The analysis for the conformity cannabis motive did not run, likely because there were not enough participants in the model combined with unbalanced conditions. This motive was only endorsed three times on co-use days, and a total of 13 times on any cannabis use day. As seen in Table 8, the likelihood of an individual reporting any of the other four cannabis motives (i.e., availability/boredom, celebration, coping, and enjoyment) was not significantly different for a CAM use day compared to a SAM use day.

Regarding person-level effects, the likelihood of reporting any type of cannabis motive was not significantly associated with proportion of CAM use days (compared to SAM use days) during the study period.

Table 8

Multilevel Model of Co-Use Days Predicting Cannabis Motives

	Availability/boredom			Celebration			Coping			Enjoyment		
	B (*SE*)	*p*	OR [CI]	*B* (*SE*)	*p*	OR [CI]	*B* (*SE*)	*p*	OR [CI]	*B* (*SE*)	*p*	OR [CI]
Intercept	-1.94 (1.04)	.090	0.14 [0.01, 1.43]	-1.00 (0.49)	.067	0.37 [0.13, 1.09]	-2.41** (0.73)	.007	0.09 [0.02, 0.45]	4.19* (1.36)	.010	65.81 [3.31, 1307.13]
Level 1: Day level												
Type of use day (i.e., CAM days)	-5.74 (7.37)	.440	0.003 [0.00, 8583.30]	-2.19 (1.20)	.074	0.11 [0.01, 1.25]	-2.23 (1.56)	.159	0.11 [0.01, 2.46]	3.75 (7.99)	.641	42.54 [0.00, 393072103.81]
Level 2: Person level												
Type of use day_aggregated (i.e., CAM days)	-3.12 (7.62)	.691	0.04 [0.00, 855239.73]	-1.76 (2.28)	.456	0.17 [0.001, 25.88]	4.45 (2.81)	.142	4.45 [0.18, 41272.66]	1.40 (8.42)	.871	4.06 [0.00, 453330618.27]
Past 30-day alcohol frequency	0.03 (0.08)	.707	1.03 [0.86, 1.24]	-0.05 (0.89)	.401	0.95 [0.82, 1.09]	0.07 (0.09)	.438	1.08 [0.88, 1.32]	`0.02 (0.12)	.863	1.02 [0.79, 1.32]
Gender	-0.38 (1.16)	.750	0.68 [0.05, 8.79]	1.41 (0.89)	.141	4.11 [0.58, 29.17]	1.60 (1.26)	.230	4.94 [0.31, 78.30]	-1.07 (1.48)	.484	0.34 [0.01, 8.82]

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

Expectancies. Two MLM analyses examined if alcohol and cannabis-related expectancies regarding relaxation and tension reduction vary between SAM and CAM use days (Research question 2.2; level 1), one for alcohol-related expectancies and one for cannabis-related expectancies. The equation for alcohol-related expectancies is shown below:

$$\text{Level 1 model: } \text{Alc\_expect}_{ti} = \pi_{0i} + \pi_{1i}(\text{type\_of\_use\_day}_{ti}) + e_{ti}$$

$$\text{Level 2 model: } \pi_{0i} = \beta_{00} + \beta_{01}(\text{type\_of\_use\_day\_agg}_{i}) + \beta_{02}(\text{gender}_{i}) + \beta_{03}(\text{alcohol\_30}_{i}) + r_{0i}$$

$$\pi_{1i} = \beta_{10}$$

The outcome for the level 1 equation are alcohol expectancies reported by individual *i* on that day (time *t*). π_{0i} in the level 1 equation (also the outcome in the level 2 equation) is the intercept for individual *i*, which represents the alcohol expectancies reported by an individual when all predictors (i.e., $\text{type\_of\_use\_day}_{ti}$) are at zero, which would be SAM use days. π_{1i} represents how alcohol expectancies reported changes for CAM use days (i.e., $\text{type\_of\_use\_day}_{ti} = 1$). The residual e_{ti} is the difference between the predicted alcohol expectancies and the actual alcohol expectancies reported by an individual. At Level 2, β_{00} is the grand intercept, or the expected alcohol expectancies when all predictors (e.g., $\text{type\_of \_use\_day\_agg}_{i,}$) are at zero, which would be for average SAM use days, not cisgender men, and average past 30-day alcohol frequency in the sample. β_{01} represents how the predicted value for alcohol expectancies changes for individuals with more average CAM use days during the study period (i.e., $\text{type\_of\_use\_day \_agg}_{i}$ increases). β_{02} and β_{03} represent the effect of covariates (gender and past 30-day alcohol frequency, respectively), and are the slopes for the relationships between alcohol expectancies and covariates for the sample, or how alcohol expectancies change for cisgender men and more frequent alcohol consumption, respectively. The residual r_{0i} is the difference between alcohol expectancies intercept for an individual and the expected value from the model.

There was not a significant difference between the number of alcohol expectancies reported on CAM use days compared to SAM use days, B = -0.20, SE = 0.35, p = .579. Regarding person-level effects, there was not a significant association between alcohol expectancies and proportion of CAM use days (compared to SAM days) during the study, B = 0.51, SE = 2.13, p = .817. There was not a significant association between alcohol expectancies and past 30-day alcohol frequency, B = -0.07, SE = 0.05, p = .198, or gender, B = 0.44, SE = 0.86, p = .632.

The equation for cannabis-related expectancies is shown below:

$$\text{Level 1 model: Cannabis\_expect}_{ti} = \pi_{0i} + \pi_{1i}(\text{type\_of\_use\_day}_{ti}) + e_{ti}$$

$$\text{Level 2 model: } \pi_{0i} = \beta_{00} + \beta_{01}(\text{type\_of\_use\_day\_agg}_i) + \beta_{02}(\text{gender}_i) + \beta_{03}(\text{alcohol\_30}_i) + r_{0i}$$

$$\pi_{1i} = \beta_{10}$$

The outcome for the level 1 equation is cannabis expectancies reported by individual i on that day (time t). π_{0i} in the level 1 equation (also the outcome in the level 2 equation) is the intercept for individual i, which represents cannabis expectancies reported for an individual when all predictors (i.e., $\text{type\_of\_use\_day}_{ti}$) are at zero, which would be SAM use days. π_{1i} represents how cannabis expectancies reported changes for CAM use days (i.e., $\text{type\_of\_use\_day}_{ti} = 1$). The residual e_{ti} is the difference between the predicted cannabis expectancies and the actual cannabis expectancies reported by an individual. At Level 2, β_{00} is the grand intercept, or the expected cannabis expectancies when all predictors (e.g., $\text{type\_of\_use\_day\_agg}_{i,}$) are at zero, which would be for average SAM use days, not cisgender men, average past 30-day alcohol frequency, and average past 30-day cannabis frequency in the sample. β_{01} represents how predicted value for cannabis expectancies changes for individuals with more CAM use days during the study period (i.e., type_of_use_day $\_agg_i$ increases). β_{02} and

β_{03} represent the effects of covariates (gender and past 30-day alcohol frequency, respectively), and are the slopes for the relationships between cannabis expectancies and covariates for the sample, or how cannabis expectancies change for cisgender men and more frequent alcohol consumption, respectively. The residual r_{0i} is the difference between cannabis expectancies intercept for an individual and the expected value from the model.

There was not a significant difference between the number of cannabis expectancies reported on CAM use days compared to SAM use days, B = -0.80, SE = 0.44, p = .105. Regarding person-level effects, there was not a significant association between alcohol expectancies and proportion of CAM use days (compared to SAM days) during the study, B = -2.66, SE = 2.14, p = .261. There was not a significant association between alcohol expectancies and past 30-day alcohol frequency, B = -0.00, SE = 0.05, p = .025, or gender, B = 0.24, SE = 0.87, p = .795.

Context. One multinomial and one binomial MLM analysis were conducted to examine if context varies between SAM and CAM use days (Research questions 2.3 and 2.4; level 1), one for environmental context (six levels) and one for social context (two levels). As the outcome for environmental context is multinomial, there were a series of outcomes, comparing each environmental context to the reference group. The reference group for each analysis was selected after determining the most frequently endorsed environmental/social context. The equation for environmental context (comparing enclosed motor vehicle to own home/apartment/dorm [reference group]; RQ 2.3) is shown below:

$$\text{Level 1 model: Prob}[enclosed\_mv = 1 \mid \pi_1] = \phi_{1ti}$$

$$\log[\phi_{1ti}/\ \phi_{6ti}] = \pi_{0i(1)} + \pi_{1i(1)}(\text{type\_of\_use\_day}_{ti}) + e_{ti}$$

Level 2 model: $\pi_{0i} = \beta_{00(1)} + \beta_{01(1)}(\text{type\_of\_use\_day\_agg}_i) + \beta_{02(1)}(\text{gender}_i) + \beta_{03(1)}(\text{alcohol\_30}_i) + r_{0i}$

$$\pi_{1i(1)} = \beta_{10(1)}$$

The outcome for the level 1 equation is the likelihood of an individual being in an enclosed motor vehicle than in their own home/apartment/dorm on any alcohol and cannabis use day. $\pi_{0i(1)}$ in the level 1 equation is the intercept for an individual *i* (also the outcome in the level 2 equation), which represents the likelihood of an individual being in an outdoor/public place rather than their own home/apartment/dorm when all predictors (i.e., $\text{type\_of\_use\_day}_{ti}$) are at zero, which would be SAM use days. The subscript 1 in parentheses refers to this as the first intercept (for enclosed motor vehicle), with additional intercepts to be estimated in separate equations for other environmental contexts (2 through 5 reflecting each environmental context being compared to their own home/apartment/dorm). $\pi_{1i(1)}$ is the slope for the relationship between enclosed motor vehicle and CAM use days, or how the likelihood of being in an enclosed motor vehicle compared to an individual's own home/apartment/dorm changes for a CAM use day compared to a SAM use day. Positive values would reflect that the likelihood of participants being in an enclosed motor vehicle increases on CAM use days compared to SAM use days, whereas negative values would reflect that the likelihood of being in an enclosed motor vehicle decreases on CAM use days compared to SAM use days; this is the within-person effect of CAM use. At Level 2, $\beta_{00(1)}$ is the intercept of the sample, reflecting the expected likelihood when all predictors are out zero, or the grand mean of the likelihoods for being in an enclosed motor vehicle on SAM use days for not cisgender men and average past 30-day alcohol frequency. $\beta_{01(1)}$ is the slope for the relationship between environmental context (i.e., likelihood of being in an enclosed motor vehicle) and proportion of CAM use days (i.e.,

type_of_use_day_agg$_{ti}$ = 1), or how the likelihood of being in an enclosed motor vehicle changes for individuals with greater proportion of CAM use days. Positive values would reflect that participants who engage in CAM use more often are also more likely to be in an enclosed motor vehicle regularly whereas negative values would reflect that participants who engage in CAM use more often are less likely to be in an enclosed motor vehicle regularly; this is the between-person effect of CAM use. $\beta_{02(1)}$ and $\beta_{03(1)}$ represent the covariates (gender and past 30-day alcohol frequency, respectively), and are the slopes for the relationships between each covariate and likelihood of being in an enclosed motor vehicle, or how the likelihood of being in an enclosed motor vehicle changes for cisgender men and individuals with more frequent alcohol consumption, respectively. The residual r_{0i} is the difference between the predicted likelihood of being in an enclosed motor vehicle (intercept) for the overall sample, and the predicted likelihood of being in an enclosed motor vehicle (intercept) for each specific individual. All parameter estimates include the subscript 1 in parentheses to indicate the equations reflect reporting being in an enclosed motor vehicle (rather than own home/apartment/dorm). This series of equations is repeated for each type of environmental context (except in their own home/apartment/dorm) reflecting the likelihood of being in that environmental context (as opposed to their own home/apartment/dorm), but all are conducted simultaneously as a single analysis.

This analysis did not run, as there were not enough data to compare two groups (i.e., SAM use day versus CAM use day) across six groups (environmental contexts). For example, being in an enclosed motor vehicle was only endorsed on one co-use day, being in an outdoor/public space as only endorsed on two co-use days, and being at a bar/restaurant was only endorsed on four co-use days.

The equation for social context (comparing with others to alone [reference group]) is shown below:

$$\text{Level 1 model: Prob}[\textit{with\_others} = 1 \mid \pi_1] = \phi_{1ti}$$

$$\log[\phi_{1ti}/\ \phi_{2ti}] = \pi_{0i(1)} + \pi_{1i(1)}(\text{type\_of\_use\_day}_{ti}) + e_{ti}$$

$$\text{Level 2 model: } \pi_{0i} = \beta_{00(1)} + \beta_{01(1)}(\text{type\_of\_use\_day\_agg}_i) + \beta_{02(1)}(\text{gender}_i) + \beta_{03(1)}(\text{alcohol\_30}_i) + r_{0i}$$

$$\pi_{1i(1)} = \beta_{10(1)}$$

The outcome for the level 1 equation is the likelihood of an individual using alcohol and cannabis with others rather than alone on any alcohol and cannabis use day. $\pi_{0i(1)}$ in the level 1 equation is the intercept for an individual *i* (also the outcome in the level 2 equation), which represents the likelihood of an individual using alcohol and cannabis with others when all predictors (i.e., $\text{type\_of\_use\_day}_{ti}$) are at zero, which would be SAM use days. $\pi_{1i(1)}$ is the slope for the relationship between being with others and CAM use days, or the change in the likelihood for being with others compared to being alone on CAM use days. Positive values would reflect that the likelihood of participants being with others increases on CAM use days compared to SAM use days, whereas negative values would reflect that the likelihood of being with others decreases on CAM use days compared to SAM use days; this is the within-person effect of CAM use. At Level 2, $\beta_{00(1)}$ is the intercept of the sample, reflecting the expected likelihood when all predictors are at zero, or the grand mean of the likelihoods for each social context on SAM use days for not cisgender men and average past 30-day alcohol frequency. $\beta_{01(1)}$ is the slope for the relationship between being with others and proportion CAM use days (i.e., $\text{type\_of\_use\_day\_agg}_i = 1$), or how the likelihood of being with others changes for individuals with greater proportions of CAM days. Positive values would reflect that participants who engage in CAM

use more often are also more likely to be with others regularly whereas negative values would reflect that participants who engage in CAM use more often are less likely to be with others regularly; this is the between-person effect of CAM use. $\beta_{02(1)}$ and $\beta_{03(1)}$ represent the covariates (gender and past 30-day alcohol frequency, respectively), and are the slopes for the relationships between each covariate and likelihood of being with others, or how the likelihood of being with others changes for cisgender men and individuals with more frequent alcohol consumption, respectively. The residual r_{0i} is the difference between the predicted likelihood of being with others (intercept) for the overall sample, and the predicted likelihood of being with others (intercept) for each specific individual.

The likelihood of participants being with others on CAM use days was not significantly different from SAM use days, B = -2.93, SE = 1.61, OR = 0.05, p = .074. At the person level, there was not a significant association between the likelihood of participants being with and proportion of CAM use days (versus SAM use days) during the study period, B = -7.69, SE = 3.54, OR = 0.00, p = .053. There was not a significant association between the likelihood of participants being with others and past 30-day alcohol frequency, B = -0.03, SE = 0.10, p = .778, or gender, B = 0.73, SE = 1.42, p = .617.

Level of Use. An MLM analysis examined if more alcohol is consumed on SAM use days versus CAM use days (Hypothesis 2.2; level 1). The equation for this analysis is shown below:

$$\text{Level 1 model: } \text{alcohol\_quant}_{ti} = \pi_{0i} + \pi_{1i}(\text{type\_of\_use\_day}_{ti}) + e_{ti}$$

$$\text{Level 2 model: } \pi_{0i} = \beta_{00} + \beta_{01}(\text{type\_of\_use\_day\ \_agg}_i) + \beta_{02}(\text{gender}_i) + \beta_{03}(\text{alcohol\_30}_i) + r_{0i}$$

$$\pi_{1i} = \beta_{10}$$

The outcome for the level 1 equation is the amount of alcohol consumed (in standard drinks) reported by individual *i* on that day (time *t*). π_{0i} in the level 1 equation (also the outcome in the level 2 equation) is the intercept for individual *i*, which represents the reported amount of alcohol consumed by an individual when all predictors (i.e., type_of_use_day$_{ti}$) are at zero, which would be SAM use days. π_{1i} represents how reported amount of alcohol consumed changes for CAM use days (i.e., type_of_use_day$_{ti}$ = 1). The residual e_{ti} is the difference between the predicted amount of alcohol consumed and the actual reported amount of alcohol consumed by an individual. At Level 2, β_{00} is the grand intercept of the sample, or the expected amount of alcohol consumed when all predictors (e.g., type_of_use_day _agg$_i$) are at zero, which would be for average SAM use days in the sample, not cisgender men and average past 30-day alcohol frequency. β_{01} represents how the expected amount of alcohol consumed changes for individuals with more CAM use days during the study period (i.e., type_of_use_day _agg$_i$ increases). β_{02} and β_{03} represent the effects of covariates (gender and past 30-day alcohol frequency, respectively), and are the slopes for the relationships between the amount of alcohol consumed and the covariates for the sample, or how amount of alcohol consumed changes for cisgender men and more frequent alcohol consumption, respectively. The residual r_{0i} is the difference between the amount of alcohol consumed intercept for an individual and the expected value from the model.

There was not a significant difference between amount of standard drinks consumed on CAM versus SAM use days, B = -1.51, SE = 0.83, p = .076. At the person level, there was not a significant association between number of standard drinks consumed and proportion of CAM use days (versus SAM use days) during the study period, B = -0.03, SE = 2.68, p = .991. There was not a significant association between number of standard drinks consumed and past 30-day alcohol frequency, B = 0.13, SE = 0.08, p = .141, or gender, B = 5.20, SE = 1.14, p < .001.

An MLM analysis was used to examine if more cannabis is used on SAM use days versus CAM use days (Research question 2.5; level 1). The equation for this analysis is shown below:

$$\text{Level 1 model: } \text{cannabis\_quant}_{ti} = \pi_{0i} + \pi_{1i}(\text{type\_of\_use\_day}_{ti}) + e_{ti}$$

$$\text{Level 2 model: } \pi_{0i} = \beta_{00} + \beta_{01}(\text{type\_of\_use\_day\_agg}_i) + \beta_{02}(\text{gender}_i) + \beta_{03}(\text{alcohol\_30}_i) + r_{0i}$$

$$\pi_{1i} = \beta_{10}$$

The outcome for the level 1 equation is the amount of cannabis used (in grams) reported by individual *i* on that day (time *t*). π_{0i} in the level 1 equation (also the outcome in the level 2 equation) is the intercept for individual *i*, which represents the reported amount of cannabis used by an individual when all predictors (i.e., $\text{type\_of\_use\_day}_{ti}$) are at zero, which would be SAM use days. π_{1i} represents how reported amount of cannabis used changes for CAM use days (i.e., $\text{type\_of\_use\_day}_{ti} = 1$). The residual e_{ti} is the difference between the predicted amount of cannabis used and the actual reported amount of cannabis used by an individual. At Level 2, β_{00} is the grand intercept of the sample, or the expected amount of cannabis used when all predictors (e.g., $\text{type\_of\_use\_day\_agg}_i$) are at zero, which would be for average SAM use days in the sample, not cisgender men, and average past 30-day alcohol frequency. β_{01} represents how the expected amount of cannabis used changes for individuals with more CAM use days during the study period (i.e., $\text{type\_of\_use\_day\_agg}_i$ increases). β_{02} and β_{03} represent the effects of covariates (gender and past 30-day alcohol frequency, respectively), and are the slopes for the relationships between the amount of cannabis used and the covariates for the sample, or how amount of cannabis used changes for cisgender men and more frequent alcohol consumption, respectively. The residual r_{0i} is the difference between the amount of cannabis used intercept for an individual and the expected value from the model.

There was not a significant difference in the amount of cannabis used by participants on CAM use days compared to SAM use days, $B = 0.21$, $SE = 0.19$, $p = .287$. At the person level, there was not a significant association between amount of cannabis used and proportion of CAM use days (versus SAM days) during the study period, $B = 0.47$, $SE = 1.02$, $p = .655$. There was not a significant association between amount of cannabis used and past 30-day alcohol frequency, $B = 0.00$, $SE = 0.03$, $p = .927$, or gender, $B = 0.31$, $SE = 0.42$, $p = .483$.

Aim 3

All analyses for Aim 3 examined within-person differences at level 1 as well as between-person differences at level 2. Aim 3 analyses were conducted with data for SAM days only (e.g., only types of alcohol and routes of cannabis administration used on SAM days; $n = 60$).

Consequences. MLM analyses examined if SAM consequences vary by route of cannabis administration on SAM use days, specifically if those who use concentrates (reference group) experience a greater number of SAM consequences than other routes of cannabis administration (Hypothesis 3.1; level 1). A similar analysis examined if SAM consequences vary by type of alcohol consumed on SAM use days, specifically if those who consume shots (reference group) experience a greater number of SAM consequences than other types of alcohol (Hypothesis 3.2; level 1). The equation for Hypothesis 3.1 is below:

Level 1 model: $\text{SAM\_conseq}_{ti} = \pi_{0i} + \pi_{1i}(\text{plant}_{ti}) + \pi_{2i}(\text{edibles}_{ti}) + \pi_{3i}(\text{multiple\_routes}_{ti}) + e_{ti}$

Level 2 model: $\pi_{0i} = \beta_{00} + \beta_{01}(\text{plant\_agg}_i) + \beta_{02}(\text{edibles\_agg}_i) + \beta_{03}(\text{multiple\_routes\_agg}_i) + \beta_{05}(\text{gender}_i) + \beta_{06}(\text{alcohol\_30}_i) + r_{0i}$

$$\pi_{1i} = \beta_{10}$$

$$\pi_{2i} = \beta_{20}$$

$$\pi_{3i} = \beta_{30}$$

The outcome for the level 1 equation is SAM consequences reported by an individual *i* on that day (time *t*). π_{0i} in the level 1 equation (also the outcome in the level 2 equation) is the intercept for individual *i*, which represents the total number of SAM consequences reported for an individual when all predictors (e.g., $plant_{ti}$) are at zero, which would be for concentrates. π_{1i}, $\pi_{2i,}$ $\pi_{3i,}$ π_{4i} represent how the total number of SAM consequences reported changes for each route of cannabis administration (plant, edibles, and multiple routes of administration, respectively). The residual e_{ti} is the difference between the predicted total number of SAM consequences and the actual total number of SAM consequences reported by an individual. At level 2, β_{00} is the grand intercept of the sample, or the expected total number of SAM consequences when all predictors (e.g., $plant\_agg_i$) are at zero, which would be for average concentrates used, not cisgender men, and average past 30-day alcohol frequency. $\beta_{01,}$ $\beta_{02,}$ and β_{03} represent how the total number of SAM consequences reported changes for individuals who use plant, edibles, and multiple routes of administration more frequently during the study period (e.g., $plant\_agg_i$ increases). β_{05} and β_{06} represent the effects of covariates (gender and past 30-day alcohol frequency, respectively), and are the slopes for the relationships between total SAM consequences and covariates for the sample, or how total SAM consequences change for cisgender men and more frequent alcohol consumption, respectively. The residual r_{0i} is the difference between the total number of SAM consequences intercept for an individual and the expected value from the model.

As seen in Table 9, route of cannabis administration was not significantly associated with number of consequences reported on SAM use days.

Regarding between-person effects, there were no significant differences in number of SAM consequences reported for those who reported using more plant, edibles, or multiple routes

of administration compared to those who reported using more concentrates during the study period.

Table 9

Multilevel Model of Route of Cannabis Administration Predicting Number of SAM Consequences

	B (*SE*)	*p*
Intercept	0.44 (0.31)	.196
Level 1: Day level		
Plant	0.58 (0.59)	.328
Edibles	-0.66 (0.81)	.421
Multiple Routes of Administration	0.28 (0.39)	.476
Level 2: Person level		
Plant – aggregated	1.34 (0.87)	.159
Edibles – aggregated	1.68 (1.35)	.244
Multiple routes of administration – aggregated	0.06 (2.00)	.977
Past 30-day alcohol quantity	0.04 (0.04)	.382
Gender	1.85* (0.63)	.016

*$p < .05$.

The equation for Hypothesis 3.2 is below:

$$\text{Level 1 model: } SAM\_conseq_{ti} = \pi_{0i} + \pi_{1i}(beer_{ti}) + \pi_{2i}(hard\_cider_{ti}) + \pi_{3i}(wine_{ti}) + \pi_{4i}(hard\_seltzer_{ti}) + \pi_{5i}(multiple\_types_{ti}) + e_{ti}$$

$$\text{Level 2 model: } \pi_{0i} = \beta_{00} + \beta_{01}(beer\_agg_i) + \beta_{02}(hard\_cider\_agg_i) + \beta_{03}(wine\_agg_i) + \beta_{04}(hard\_seltzer\_agg_i) + \beta_{05}(multiple\_types\_agg_i) + \beta_{08}(gender) + \beta_{09}(alcohol\_30) + r_{0i}$$

$$\pi_{1i} = \beta_{10}$$

$$\pi_{2i} = \beta_{20}$$

$$\pi_{3i} = \beta_{30}$$

$$\pi_{4i} = \beta_{40}$$

$$\pi_{5i} = \beta_{50}$$

The outcome for the level 1 equation is SAM consequences reported by an individual *i* on that day (time *t*). π_{0i} in the level 1 equation (also the outcome in the level 2 equation) is the intercept for an individual *i*, which represents the total number of SAM consequences reported for an individual when all predictors (e.g., $beer_{ti}$) are at zero, which would be liquor (mixed drinks or shots). π_{1i}, $\pi_{2i,}$ $\pi_{3i,}$ $\pi_{4,}$ and $\pi_{5i,}$ represent how the total number of SAM consequences reported changes for each type of alcohol (beer, hard cider, wine, hard seltzer, and multiple types of alcohol respectively). The residual e_{ti} is the difference between the predicted total number of SAM consequences and the actual total number of SAM consequences reported by an individual. At level 2, β_{00} is the grand intercept of the sample, or the expected total number of SAM consequences when all predictors (e.g., $beer\_agg_i$) are at zero, which would be for average liquor (mixed drinks or shots) consumed, not cisgender men, and average past 30-day alcohol 30-dayin the sample. $\beta_{01,}$ $\beta_{01,}$ $\beta_{02,}$ $\beta_{03,}$ $\beta_{04,}$ and $\beta_{05,}$ represent how the total number of SAM

consequences reported changes for individuals who consume beer, hard cider, wine, hard seltzer, and multiple types of alcohol more during the study period (e.g., $beer\_agg_i$ increases). β_{08} and β_{09} represent the effects of covariates (gender and past 30-day alcohol frequency, respectively), and are the slopes for the relationships between total SAM consequences and covariates for the sample, or how total SAM consequences changes for cisgender men and more frequent alcohol consumption, respectively. The residual r_{0i} is the difference between the total number of SAM consequences intercept for an individual and the expected value from the model.

As seen in Table 10, type of alcohol consumed was not significantly associated with number of consequences reported on SAM use days. Regarding between-person effects, There were no significant differences in number of SAM consequences between those who consumed beer, hard cider, wind, hard seltzer, or multiple types of alcohol more than liquor (mixed drinks or shots) during the study period.

Table 10

Multilevel Model of Type of Alcohol Predicting Number of SAM Consequences

	B (*SE*)	*p*
Intercept	0.71 (0.42)	.134
Level 1: Day level		
Beer	-0.03 (0.58)	.959
Hard cider	-0.46 (0.71)	.519
Wine	-0.17 (0.42)	.687
Hard seltzer	-0.32 (0.41)	.437
Multiple types of alcohol	0.27 (0.31)	.377
Level 2: Person level		
Beer – aggregated	0.15 (1.17)	.899
Hard cider – aggregated	-6.67 (5.21)	.241
Wine – aggregated	1.43 (1.06)	.218
Hard seltzer – aggregated	0.19 (0.95)	.848
Past 30-day alcohol frequency	0.03 (.05)	.549
Gender	0.96 (1.03)	.383

Motives. To examine if SAM motives vary by type/route of administration of alcohol and cannabis on SAM use days (Research question 3.1; level 1), eight binomial MLM analyses were conducted. One analysis was conducted for each of the five subscales of the B-SMM (Conway et al., 2020) for type of alcohol consumed and route of cannabis administration. The reference group for each subsequent analysis was decided after determining which type of alcohol and route of cannabis administration is the most frequently used (see Aim 1 above). An example of the type of alcohol (with multiple types of alcohol as the reference group) and SAM conformity motive equation is shown below:

$$\text{Level 1 model: Prob}[SAMmotive\_conform=1|\ \pi_1] = \phi_{1ti}$$

$$\log[\phi_{1ti}/\ \phi_{2ti}] = {}_{\pi 0i(1)}\ \pi_{1i(1)}(\text{beer}_{ti}) + \pi_{2i(1)}(\text{hard\_cider}_{ti}) + \pi_{3i(1)}(\text{wine}_{ti}) + \pi_{4i(1)}(\text{hard\_seltzer}_{ti}) + \pi_{5i(1)}(\text{shots}_{ti}) + \pi_{6i(1)}(\text{mixed\_drinks\_caf}_{ti}) + \pi_{7i(1)}(\text{mixed\_drinks\_uncaf}_{ti}) + e_{ti}$$

$$\text{Level 2 model: } \pi_{0i} = \beta_{00(1)} + \beta_{01(1)}(\text{beer\_agg}_i) + \beta_{02(1)}(\text{hard\_cider\_agg}_i) + \beta_{03(1)}(\text{wine\_agg}_i) + \beta_{04(1)}(\text{hard\_seltzer\_agg}_i) + \beta_{05(1)}(\text{shots\_agg}_i) + \beta_{06(1)}(\text{mixed\_drinks\_caf\_agg}_i) + \beta_{07(1)}(\text{mixed\_drinks\_uncaf\_agg}_i) + \beta_{08(1)}(\text{gender}) + \beta_{09(1)}(\text{alcohol\_30}) + r_{0i}$$

$$\pi_{1i(1)} = \beta_{10}$$

$$\pi_{2i(1)} = \beta_{20}$$

$$\pi_{3i(1)} = \beta_{30}$$

$$\pi_{4i(1)} = \beta_{40}$$

$$\pi_{5i(1)} = \beta_{50}$$

$$\pi_{6i(1)} = \beta_{60}$$

$$\pi_{7i(1)} = \beta_{70}$$

The outcome for the level 1 equation is the likelihood of an individual reporting the SAM conformity motive on any SAM use day. π_{0i} in the level 1 equation (also the outcome in the level

2 equation) is the intercept for an individual *i*, which represents the likelihood of an individual reporting the SAM conformity motive when all predictors (e.g., $beer_{ti}$) are at zero, which would be multiple types of alcohol. $\pi_{1i(1)}$, $\pi_{2i(1)}$, $\pi_{3i(1)}$, $\pi_{4i(1)}$, $\pi_{5i(1)}$, $\pi_{6i(1)}$, and $\pi_{7i(1)}$ are the slopes for the relationships between reporting the SAM conformity motive and each type of alcohol (beer, hard cider, wine, hard seltzer, shots (liquor), mixed drinks caffeinated, , and mixed drinks un-caffeinated, respectively), or how the likelihood for reporting the SAM conformity motive compared to not reporting it when types of alcohol other than multiple types of alcohol compared to consuming multiple types of alcohol. Positive values would reflect that the likelihood of participants reporting the SAM conformity motive increases on days when other types of alcohol are consumed compared to days when multiple types of alcohol are consumed, whereas negative values would reflect that the likelihood of reporting the SAM conformity motive decreases on days when other types of alcohol are consumed compared to days when multiple types of alcohol are consumed; these are the within-person effect of consuming other types of alcohol other than multiple types of alcohol. At level 2, $\beta_{00(1)}$ is the intercept of the sample, reflecting the expected likelihood for reporting the SAM conformity motive when all predictors (e.g., $beer\_agg_i$) are at zero, or the grand mean of the likelihoods for reporting the SAM conformity motive on days when multiple types of alcohol are consumed for not cisgender men and average past 30-day alcohol frequency. $\beta_{01(1)}$, $\beta_{01(1)}$, $\beta_{02(1)}$, $\beta_{03(1)}$, $\beta_{04(1)}$, $\beta_{05(1)}$, $\beta_{06(1)}$, and β_{07} are the slopes for the relationship reporting the SAM conformity motive and proportion of beer, hard cider, wine, hard seltzer, shots (liquor), mixed drinks caffeinated, and mixed drinks un-caffeinated, (e.g., $beer\_agg_i = 1$), or how the likelihood for reporting the SAM conformity motive changes for individuals with greater proportion of consuming other types of alcohol other than multiple types of alcohol among individuals. Positive values would reflect that participants who use other types

of alcohol other than multiple types of alcohol more often are also more likely to report the SAM conformity motive regularly, whereas negative values would reflect that participants who consume other types of alcohol other than multiple types of alcohol more often are less likely to report the SAM conformity motive regularly; this is the between-person effect of using other types of alcohol other than multiple types of alcohol. β_{08} and β_{09} represent the covariates (gender and past 30-day alcohol frequency, respectively), and are the slopes for the relationships between the likelihood of reporting the SAM conformity motive and covariates, or how the likelihood of reporting the SAM conformity motive changes for cisgender men and more frequent alcohol consumption, respectively. The residual r_{0i} is the difference between the predicted likelihood of reporting the SAM conformity motive (intercept) for the overall sample and the predicted likelihood of reporting the SAM conformity motive (intercept) for each specific individual.

The analyses for research question 3.1 with alcohol types ran with errors, thus did not have results that could be interpreted. This could be due to seven groups (alcohol types) being compared across two groups (binomial outcome of SAM motives). For example, consuming hard cider was only endorsed on one SAM use day, consumed a caffeinated beverage was only reported on one SAM use day, and consuming shots (liquor) was only reported on two SAM use days. Additionally, none of the participants endorsed experiencing the SAM motive of conformity.

An example of the route of cannabis administration (with plant as the reference group) and SAM motive conformity subscale equation is shown below:

Level 1 model:

$$\text{Prob}[SAMmotive\_conform = | \pi_1] = \phi_{1ti}$$

$$= \log[\phi_{1ti} / \phi_{2ti}] = \pi_{0i(1)} + \pi_{1i(1)}(\text{edibles}_{ti}) + \pi_{2i(1)}(\text{concentrates}_{ti}) + \pi_{3i(1)}(\text{multiple\_routes}_{ti}) + e_{ti}$$

Level 2 model:

$$\pi_{0i} = \beta_{00(1)} + \beta_{01(1)}(\text{edibles\_agg}_i) + \beta_{02(1)}(\text{concentrates\_agg}_i) + \beta_{03(1)}(\text{multiple\_routes\_agg}_i) + \beta_{05(1)}(\text{gender}_i) + \beta_{06(1)}(\text{alcohol\_30}_i) + r_{0i}$$

$$\pi_{1i(1)} = \beta_{10(1)}$$

$$\pi_{2i(1)} = \beta_{20(1)}$$

$$\pi_{3i(1)} = \beta_{30(1)}$$

The outcome for the level 1 equation is the likelihood of an individual reporting the SAM conformity motive on any SAM use day. π_{0i} in the level 1 equation (also the outcome in the level 2 equation) is the intercept for individual *i*, which represents the likelihood of an individual reporting the SAM conformity motive when all predictors (e.g., edibles_{ti}) are at zero, which would be for plant. $\pi_{1i(1)}$, $\pi_{2i(1)}$, and $\pi_{3i(1)}$ are the slopes for the relationship between reporting the SAM conformity motive and each route of cannabis administration (edibles, concentrates, , and multiple routes of administration, respectively), or how the likelihood for reporting the SAM conformity motive compared to not reporting it when routes of cannabis administration other than plant compared to using plant. Positive values would reflect that the likelihood of participants reporting the SAM conformity motive increases on days when other routes of cannabis administration compared to days when plant are consumed, whereas negative values would reflect that the likelihood of reporting the SAM conformity motive decreases on days when other routes of cannabis administration are used compared to days when plant are used; these are the within-person effect of using other routes of cannabis administration other than plant. At level 2, $\beta_{00(1)}$ is the intercept of the sample, reflecting the expected likelihood for reporting the SAM conformity motive when all predictors (e.g., edibles_agg_i) are at zero, which would be the grand mean of the likelihoods for reporting the SAM conformity motive on days

when plant are used for not cisgender men and average past 30-day alcohol frequency. $\beta_{01(1),}$ $\beta_{02(1),}$ and $\beta_{03(1)}$ represent the slopes for the relationship between reporting the SAM conformity motive and proportion of edibles, concentrates, , and multiple routes of administration (e.g., edibles_agg$_i$ = 1), or how the likelihood for reporting the SAM conformity motive changes for individuals with greater proportion of using other routes of cannabis administration other than plant among individuals. Positive values would reflect that participants who use other routes of cannabis administration other than plant more often are also more likely to report the SAM conformity motive regularly, whereas negative values would reflect that participants who uses other routes of cannabis administration other than plant more often are less likely to report the SAM conformity motive regularly; this is the between-person effect of using other routes of cannabis administration other than plant. $\beta_{05(1)}$ and $\beta_{06(1)}$ represent the effects of covariates (gender and past 30-day alcohol frequency, respectively), and are the slopes for the relationships between the likelihood of reporting the SAM conformity motive and covariates, or how the likelihood of reporting the SAM conformity motive changes for cisgender men and more frequent alcohol consumption, respectively. The residual r_{0i} is the difference between the predicted likelihood of reporting the SAM conformity motive (intercept) for the overall sample and the predicted likelihood of reporting the SAM conformity motive (intercept) for each specific individual.

As seen in Table 11, there were no significant associations between the SAM motive of calm/coping and route of cannabis administration. At the person level, there were not significant associations between the SAM calm/coping motive and route of cannabis administration used more often during the study period. None of the other models for SAM motives with routes of cannabis administration as the predictors ran successfully. On SAM use days, participants

reported using cannabis edibles only two times, multiple routes of administration only six times, and cannabis concentrates only 6 times. Additionally, none of the participants endorsed experiencing the SAM motive of conformity.

Table 11

Multilevel Model of Route of Cannabis Administration Predicting Calm/Coping SAM Motive

	B (*SE*)	*p*	OR [CI]
Intercept	-0.51 (0.53)	.362	0.60 [0.18, 1.99]
Level 1: Day level			
Edibles	-1.11 (3.05)	.717	0.33 [0.001, 155.10]
Concentrates	0.52 (1.88)	.784	1.68 [0.04, 74.59]
Multiple routes of cannabis administration	-1.48 (2.00)	.462	0.23 [0.004, 12.79]
Level 2: Person level			
Edibles - aggregated	2.99 (2.20)	.208	19.88 [0.14, 2910.00]
Concentrates - aggregated	0.28 (1.54)	.858	1.33 [0.04, 43.40]
Multiple routes of cannabis administration - aggregated	4.28 (4.06)	.320	72.12 [0.01, 706178.60]
Past 30-day alcohol frequency	-0.12 (0.08)	.156	0.88 [0.74, 1.06]
Gender	0.24 (1.18)	.840	1.28 [0.09, 18.27]

Expectancies. To examine if SAM relaxation and tension reduction expectancies vary by type/route of administration of alcohol and cannabis (Research question 3.2; level 1), two MLM analyses were conducted. One analysis examined type of alcohol consumed and one examined route of cannabis administration. The equation for type of alcohol (with multiple types of alcohol as the reference group) is shown below:

$$\text{Level 1 model: } SAM\_expect_{ti} = \pi_{0i} + \pi_{1i}(beer_{ti}) + \pi_{2i}(hard\_cider_{ti}) + \pi_{3i}(wine_{ti}) + \pi_{4i}(hard\_seltzer_{ti}) + \pi_{5i}(shots_{ti}) + \pi_{6i}(mixed\_drinks\_caf_{ti}) + \pi_{7i}(mixed\_drinks\_uncaf_{ti}) + e_{ti}$$

$$\text{Level 2 model: } \pi_{0i} = \beta_{00} + \beta_{01}(beer\_agg_i) + \beta_{02}(hard\_cider\_agg_i) + \beta_{03}(wine\_agg_i) + \beta_{04}(hard\_seltzer\_agg_i) + \beta_{05}(shots\_agg_i) + \beta_{06}(mixed\_drinks\_caf\_agg_i) + \beta_{07}(mixed\_drinks\_uncaf\_agg_i) + \beta_{08}(gender) + \beta_{09}(alcohol\_30) + r_{0i}$$

$$\pi_{1i} = \beta_{10}$$

$$\pi_{2i} = \beta_{20}$$

$$\pi_{3i} = \beta_{30}$$

$$\pi_{4i} = \beta_{40}$$

$$\pi_{5i} = \beta_{50}$$

$$\pi_{6i} = \beta_{60}$$

$$\pi_{7i} = \beta_{70}$$

The outcome for the level 1 equation is SAM expectancies reported by an individual *i* on that day (time *t*). π_{0i} in the level 1 equation (also the outcome in the level 2 equation) is the intercept for an individual *i*, which represents SAM expectancies reported for an individual when all predictors (e.g., $beer_{ti}$) are at zero, which would be multiple types of alcohol. π_{1i}, $\pi_{2i,}$ $\pi_{3i,}$ $\pi_{4i,}$ $\pi_{5i,}$ $\pi_{6i,}$ and π_{7i} represent how SAM expectancies reported changes for each type of alcohol (beer, hard cider, wine, hard seltzer, shots [liquor], mixed drinks caffeinated, mixed drinks un-

caffeinated, respectively). The residual e_{ti} is the difference between the predicted SAM expectancies and the actual SAM expectancies reported by an individual. At level 2, β_{00} is the grand intercept of the sample, or the expected SAM expectancies when all predictors (e.g., $beer\_agg_i$) are at zero, which would be for average multiple types of alcohol consumed, not cisgender men, and average past 30-day alcohol frequency in the sample. $\beta_{01,}$ $\beta_{01,}$ $\beta_{02,}$ $\beta_{03,}$ $\beta_{04,}$ $\beta_{05,}$ $\beta_{06,}$ and β_{07} represent how SAM expectancies reported changes for individuals who consume beer, hard cider, wine, hard seltzer, shots (liquor), mixed drinks caffeinated, and mixed drinks un-caffeinated more during the study period (e.g., $beer\_agg_i$ increases). β_{08} and β_{09} represent the effects of covariates (gender and past 30-day alcohol frequency, respectively), and are the slopes for the relationships between SAM expectancies and covariates for the sample, or how SAM expectancies change for cisgender men and more frequent alcohol consumption, respectively. The residual r_{0i} is the difference between SAM expectancies intercept for an individual and the expected value from the model.

As seen in Table 12, on SAM use days when shots (liquor) are consumed, compared to multiple types of alcohol, participants reported experiencing, on average, 0.66 more SAM expectancies, which was a significant association ($p = .023$). All other associations between type of alcohol and SAM expectancies were not significant. At the person level, there were not significant associations between type of alcohol used more often during the study period and SAM expectancies.

Table 12

Multilevel Model of Type of Alcohol Predicting SAM Expectancies

	B (*SE*)	*p*
Intercept	5.44** (0.25)	.002
Level 1: Day level		
Beer	0.25 (0.33)	.445
Hard cider	-0.06 (0.34)	.870
Wine	-0.03 (0.26)	.898
Hard seltzer	0.59 (0.29)	.055
Shots (liquor)	0.66* (0.27)	.023
Caffeinated mixed drinks	0.08 (0.39)	.842
Un-caffeinated mixed drinks	0.16 (0.25)	.525
Level 2: Person level		
Beer - aggregated	1.35 (1.08)	.339
Hard cider - aggregated	6.79 (2.40)	.105
Wine – aggregated	-1.33 (0.77)	.226
Hard seltzer – aggregated	1.49 (.76)	.189
Shots (liquor) – aggregated	-2.80 (0.94)	.097
Caffeinated mixed drinks – aggregated	4.71 (1.78)	.118
Un-caffeinated mixed drinks – aggregated	3.03 (1.00)	.094
Past 30-day alcohol frequency	-0.06 (0.03)	.168
Gender	0.20 (1.00)	.858

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

The equation for route of cannabis administration (with plant as the reference group) is shown below:

$$\text{Level 1 model: } SAM\_expect_{ti} = \pi_{0i} + \pi_{1i}(edibles_{ti}) + \pi_{2i}(concentrates_{ti}) + \pi_{3i}(multiple\_routes_{ti}) + e_{ti}$$

$$\text{Level 2 model: } \pi_{0i} = \beta_{00} + \beta_{01}(edibles\_agg_i) + \beta_{02}(concentrates\_agg_i) + \beta_{03}(multiple\_routes\_agg_i) + \beta_{05}(gender_i) + \beta_{06}(alcohol\_30_i) + r_{0i}$$

$$\pi_{1i} = \beta_{10}$$

$$\pi_{2i} = \beta_{20}$$

$$\pi_{3i} = \beta_{30}$$

The outcome for the level 1 equation is SAM expectancies reported by an individual *i* on that day (time *t*). π_{0i} in the level 1 equation (also the outcome in the level 2 equation) is the intercept for individual *i*, which represents SAM expectancies reported for an individual when all predictors (e.g., $edibles_{ti}$) are at zero, which would be for plants. π_{1i}, $\pi_{2i,}$ and π_{3i} represent how SAM expectancies reported changes for each route of cannabis administration (edibles, concentrates, and multiple routes, respectively). The residual e_{ti} is the difference between the predicted SAM expectancies and the actual SAM expectancies reported by an individual. At level 2, β_{00} is the grand intercept of the sample, or the expected SAM expectancies when all predictors (e.g., $edibles\_agg_i$) are at zero, which would be for average plant used, not cisgender men, and average past 30-day alcohol frequency in the sample. $\beta_{01,}$ $\beta_{02,}$ and β_{03} represent how SAM expectancies reported changes for individuals who use edibles, concentrates, and multiple routes of administration more during the study period (e.g., $edibles\_agg_i$ increases). β_{05} and β_{06} represent the effects of covariates (gender and past 30-day alcohol frequency, respectively), and are the slopes for the relationships between SAM expectancies and covariates for the sample, or

how SAM expectancies change for cisgender men and more frequent alcohol consumption, respectively. The residual r_{0i} is the difference between the SAM expectancies intercept for an individual and the expected value from the model.

This analysis did not run. In addition to unbalanced categories (with spare endorsement of routes of administration other than plant), this could be due to the number of days being analyzed decreased, as the analysis of expectancies depends on participants reporting about expectancies prospectively, thus, two consecutive days are needed.

Context. To determine if the likelihood of being in a certain environmental and social context vary by type of alcohol and route of cannabis administration on SAM use days (Research questions 3.3 and 3.4; level 1), two multinomial MLM analyses and two binomial MLM analyses were conducted. Environmental (four levels) and social context (two levels) were analyzed separately for type of alcohol consumed and route of cannabis administration. As the outcome was multinomial for environmental context, there was a series of outcomes, comparing each environmental context to the reference group, which was selected after determining the most frequently endorsed environmental context. The reference group for type of alcohol and route of cannabis administration for both environmental context and social context was selected after determining the most frequently endorsed type of alcohol and route of cannabis administration. An example for route of cannabis administration (with plant as the reference group) and environmental context (with own home/apartment/dorm as the reference group compared to multiple locations) is shown below:

$$\text{Level 1 model: Prob}[\textit{multilocation} = | \pi_1] = \phi_{1ti}$$

$$\log[\phi_{1ti}/\phi_{4ti}] = \pi_{0i(1)} + \pi_{1i(1)}(\text{edibles}_{ti}) + \pi_{2i(1)}(\text{concentrates}_{ti}) + \pi_{3i(1)}(\text{multipe\_routes}_{ti}) + e_{ti}$$

$$\text{Level 2 model: } \pi_{0i} = \beta_{00(1)} + \beta_{01(1)}(\text{edibles\_agg}_i) + \beta_{02(1)}(\text{concentrates\_agg}_i) + \beta_{03(1)}(\text{multiple\_routes\_agg}_i) + \beta_{05(1)}(\text{gender}_i) + \beta_{06(1)}(\text{alcohol\_30}_i) + r_{0i}$$

$$\pi_{1i(1)} = \beta_{10(1)}$$

$$\pi_{2i(1)} = \beta_{20(1)}$$

$$\pi_{3i(1)} = \beta_{30(1)}$$

The outcome for the level 1 equation is the likelihood of an individual being in multiple locations than in their own home/apartment/dorm on any SAM use day. $\pi_{0i(1)}$ in the level 1 equation is the intercept for an individual *i* (also the outcome in the level 2 equation), which represents the likelihood of an individual being in multiple locations rather than their own home/apartment/dorm when all predictors (e.g., edibles_{ti}) are at zero, which would be for cannabis plant. The subscript 1 in parentheses refers to this as the first intercept (for multiple locations), with additional intercepts to be estimated in separate equations for other environmental contexts (2 through 3 reflecting each environmental context being compared to their own home/apartment/dorm). $\pi_{1i(1)}$, $\pi_{1i(2)}$, and $\pi_{1i(3)}$ are the slopes for the relationship between multiple locations and routes of cannabis administration (edibles, concentrates, and multiple routes of administration, respectively), or how the likelihood for being in multiple locations compared to an individual's own home/apartment/dorm changes when using a route of cannabis administration other than cannabis plant compared to using cannabis plant. Positive values would reflect that the likelihood of participants being in multiple locations increases on days when other routes of cannabis administration are used compared to days when cannabis plant are used, whereas negative values would reflect that the likelihood of being in multiple locations decreases on days when other routes of cannabis administration are used compared to days when cannabis plant are used; these are the within-person effect of using routes of cannabis

administration other than cannabis plant. At Level 2, $\beta_{00(1)}$ is the intercept of the sample, reflecting the expected likelihood when all predictors are at zero, or the grand mean of the likelihoods for being in multiple locations on days when cannabis plant is used for not cisgender men and average past 30-day alcohol frequency. $\beta_{01(1)}$, $\beta_{02(1)}$, and $\beta_{03(1)}$ are the slopes for the relationships between environmental context and proportion of edibles, concentrates, and multiple routes of cannabis administration, respectively, or how the likelihood of being in multiple locations changes for individuals with greater proportions of using edibles, concentrates, and multiple routes of cannabis administration. Positive values would reflect that participants who use routes of administration other than cannabis plant more often are also more likely to be in multiple locations regularly whereas negative values would reflect that participants who use routes of administration other than cannabis plant more often are less likely to be in multiple locations regularly; this is the between-person effect of using routes of cannabis administration other than cannabis plant. $\beta_{05(1)}$ and $\beta_{06(1)}$ represent the covariates (gender and past 30-day alcohol frequency, respectively), and are the slopes for the relationships between each covariate and likelihood of being in multiple locations, or how the likelihood of being in multiple locations changes for cisgender men and individuals with more frequent alcohol consumption, respectively. The residual r_{0i} is the difference between the predicted likelihood of being in multiple locations (intercept) for the overall sample. All parameter estimates include the subscript 1 in parentheses to indicate the equations reflect reporting being in multiple locations (rather than own home/apartment/dorm). This series of equations is repeated for each type of environmental context (except in their own home/apartment/dorm) reflecting the likelihood of being in that environmental context as opposed to their own home/apartment/dorm, but all are conducted simultaneously as a single analysis.

The analyses for environmental context did not run, as there were not enough data to compare four groups (i.e., environmental context) across eight groups (types of alcohol) and four groups (routes of administration). For example, only two types of alcohol (i.e., hard cider and un-caffeinated mixed drinks) and cannabis (i.e., cannabis concentrates and plant) were consumed in outdoor/public locations. The equation for route of cannabis administration (with plant as the reference group) and social context (comparing alone to with others [reference group]) is shown below:

$$\text{Level 1 model: Prob}[\textit{with\_others}= \mid \pi_1] = \phi_{1ti}$$

$$\log[\phi_{1ti}/\ \phi_{2ti}] = \pi_{0i(1)} + \pi_{1i(1)}(\text{edibles}_{ti}) + \pi_{2i(1)}(\text{concentrates}_{ti}) + \pi_{3i(1)}(\text{multiple\_routes}_{ti}) + e_{ti}$$

$$\text{Level 2 model: } \pi_{0i} = \beta_{00(1)} + \beta_{01(1)}(\text{edibles\_agg}_i) + \beta_{02(1)}(\text{concentrates\_agg}_i) +$$

$$\beta_{03(1)}(\text{multiple\_routes\_agg}_i) + + \beta_{05(1)}(\text{gender}_i) + \beta_{06(1)}(\text{alcohol\_30}_i) + r_{0i}$$

$$\pi_{1i(1)} = \beta_{10(1)}$$

$$\pi_{2i(1)} = \beta_{20(1)}$$

$$\pi_{3i(1)} = \beta_{30(1)}$$

The outcome for the level 1 equation is the likelihood of an individual using alcohol and cannabis with others than alone on any SAM use day. Π_{0i} in the level 1 equation is the intercept for an individual *i* (also the outcome in the level 2 equation), which represents the likelihood of an individual using alcohol and cannabis with others when all predictors (e.g., edibles_{ti}) are at zero, which would be cannabis plant. $\Pi_{1i(1)}$, $\pi_{1i(2)}$, and $\pi_{1i(3)}$ are the slopes for the relationships between being with others and routes of cannabis administration other than cannabis plant, or how the likelihood for being in with others compared to being alone when routes of cannabis administration other than cannabis plant compared to using cannabis plant. Positive values would reflect that the likelihood of participants being with others increases on days when other routes

of cannabis administration are used compared to days when cannabis plant are used, whereas negative values would reflect that the likelihood of being with others decreases on days when other routes of cannabis administration are used compared to days when cannabis plant are used; these are the within-person effect of using routes of cannabis administration other than cannabis plant. At Level 2, $\beta_{00(1)}$ is the intercept of the sample, reflecting the expected likelihood when all predictors are at zero, or the grand mean of the likelihoods for being with others on days when cannabis plant is used for not cisgender men and average past 30-day alcohol frequency. $B_{01(1)}$, $\beta_{02(1)}$, and $\beta_{03(1)}$ are the slopes for the relationship between being with others and proportion of edibles, concentrates, and multiple routes of cannabis administration, respectively (e.g., $edibles\_agg_i = 1$), or how the likelihood for being with others changes for individuals with greater proportion of using routes of cannabis administration other than cannabis plant among individuals. Positive values would reflect that participants who use routes of administration other than cannabis plant more often are also more likely to be with others regularly whereas negative values would reflect that participants who use routes of administration other than cannabis plant more often are less likely to be with others regularly; this is the between-person effect of using routes of cannabis administration other than cannabis plant. $B_{05(1)}$ and $\beta_{06(1)}$ represent the covariates (gender and past 30-day alcohol frequency, respectively), and are the slopes for the relationships between each covariate and likelihood of being with others, or how the likelihood of being with others changes for cisgender men and individuals with more frequent alcohol consumption, respectively. The residual r_{0i} is the difference between the predicted likelihood of being with others (intercept) for the overall sample, and the predicted likelihood of being with others (intercept) for each specific individual.

Neither analysis for SAM social context ran successfully. This could be due to comparing two groups (with others versus not) across four routes of cannabis administration and eight types of alcohol with such a small sample. For example, cannabis edibles were only endorsed twice, and both times they were endorsed others were present when participants were using simultaneously. Additionally, hard cider and caffeinated mixed beverages were endorsed only once each, and both times they were endorsed others were present when participants were using simultaneously.

CHAPTER IV

DISCUSSION

The purpose of the current study was to extend the research on SAM use in the college student population using a daily diary methodology. Type of alcohol and route of cannabis administration used were examined to determine if they vary across SAM days, CAM days, and single substance use days. Additionally, consequences, motives, expectancies, and environmental/social contexts were examined to determine if they vary across SAM and CAM use days, as well as types of alcohol and routes of cannabis administration. It is important to note that the current study had a small sample size (n =18), which led to the examinations being underpowered (power analysis suggested a sample size of 75 participants). This could have increased Type II errors; thus, the results of the examinations should be interpreted with caution (see Limitations for more details).

Aim 1 – Most Common Types of Alcohol and Routes of Cannabis Administration

It was determined that in a sample of college students, plant was the most common route of cannabis administration, followed by concentrates, edibles, and using multiple routes of cannabis administration. This supported my hypothesis and aligned with the literature that found that smoking was the most common route of cannabis administration in young adults and adults (Reboussin et al., 2019; Steigerwald et al., 2018). Additionally, consuming multiple types of alcohol was the most common, followed by consuming only mixed drinks (un-caffeinated), hard seltzer, wine, beer, shots (liquor), mixed drinks (caffeinated), and hard cider.

Research question 1.3 could not be interpreted due to the small sample size and inability to compare eight groups (types of alcohol) across three groups (type of use day) and across four groups (routes of cannabis administration). There was a significant difference in quantity of

alcohol consumed across types of alcohol, such that participants reported consuming more alcohol on days when they drank shots (liquor) or mixed drinks (caffeinated) than multiple types of alcohol (Research question 1.4). Previous research has found that caffeinated alcoholic beverages and liquor (such as shots) are associated with higher risk behaviors, such as experiencing more alcohol-related negative consequences (e.g., Linden-Carmichael & Lau-Barraco, 2017; Mochrie et al., 2019). Linden-Carmichael and Lau-Barraco (2017) found that college students reported experiencing more consequences on days when they consumed caffeinated alcoholic beverages than other types of alcohol. Similarly, Mochrie et al. (2019) found that college students who preferred to consume liquor (as shots or mixed drinks) experienced more consequences than those who preferred consuming beer. These findings are consistent with the current study, which found that college students drink more when they consumed liquor (shots) or caffeinated beverages. Previous research has found that college students use shots (liquor) and caffeinated alcoholic beverages for specific reasons. Callinan and MacLean (2016) found that Australian young adults choose to consume shots when their goal is to be intoxicated. Norberg et al. (2021) created a scale to assess motives of using caffeinated alcoholic beverages in young adults and found that there was a positive association between typical frequency of caffeinated alcoholic beverage use and energy enhancement motives (e.g., "It gives you energy"), after controlling for general alcohol use motives. Thus, college students may be consuming shots (liquor) and caffeinated alcoholic beverages more so than other alcohol types to reach these desired effects, which can lead to more consequences. Even though the current study's findings align with previous literature, the results should be interpreted with caution as the current study was underpowered, with only 18 participants for a total of 176 alcohol days (108 alcohol only use days, 60 SAM use days, and 8 CAM use days).

However, there were not significant differences in quantity of cannabis used across the four routes of cannabis administration (Research question 1.5). This is surprising as previous research has found that routes of cannabis administration vary in potency (Prince & Conner, 2019), thus different amounts of each route of cannabis administration would have different effects based on its potency (i.e., not as much of a potent item like cannabis concentrates would be needed to achieve the same level of "high" as a less potent item like plant). This could be a result of the current study being underpowered, with only 18 participants for a total of 166 cannabis use days (98 cannabis only use days, 60 SAM use days, and 8 CAM use days). Additionally, it is important to note that measures to assess quantity of cannabis used are still being developed and assessing quantity does not always take into account the potency of the route of cannabis administration. Standard measures that take potency into account, similar to the DDQ (Collins et al., 1985) for alcohol quantity and frequency, are needed for cannabis quantity and frequency.

Aim 2 – Consequences, Cognitions, Contexts, and Quantity of Alcohol and Cannabis Used across SAM versus CAM Days

When comparing SAM use days and CAM use days, participants reported fewer consequences on CAM use days compared to SAM use days. This supported Hypothesis 2.1 and provided more support for studies that found college students who participated in SAM use reported more consequences than those who participated in CAM use (e.g., Jackson et al., 2020). However, the current study is not in line with findings from Sokolovsky et al. (2020) that there was not a difference in consequences college students experienced on SAM versus CAM use days. One potential explanation for the difference in findings could be the time period in which consequences were measured. Jackson et al. (2020) examined consequences experienced by

participants in the past 3 months. Sokolovsky et al. (2020) examined consequences using an ecological momentary assessment (EMA) methodology in which participants were sent five surveys each day for 28 days. There may not have been as much recall bias with the EMA methodology as there may have been with the Jackson et al. (2020) methodology (asking about past 3 months) or the current study daily diary methodology (asking the previous day). Additionally, Sokolovsky et al. (2020) operationalized CAM use versus SAM use days by examining timeframes between use of alcohol and cannabis instead of relying on participants to self-report SAM versus CAM use days as the current study and Jackson et al. (2020) did (e.g., "Did you use alcohol and marijuana at the same time yesterday, such that their effects overlapped?"). More frequent assessment of alcohol and cannabis use plus not relying on retrospective self-report for determining SAM versus CAM use days may have contributed to the differences in findings regarding consequences on co-use days.

Motives for alcohol and cannabis use did not vary across SAM and CAM use days (Research question 2.1). Similarly, expectancies for alcohol and cannabis use did not vary across SAM and CAM use days (Research question 2.2). This could indicate that college students have similar alcohol- and cannabis-related motives as well as similar alcohol- and cannabis-related expectancies for using cannabis and alcohol on the same day, whether their effects overlap or not. Previous research with college students that only examined single substance use has found that alcohol and cannabis-related coping motives are associated with experiencing negative consequences (e.g., Merrill et al., 2014; Simons et al., 1998). Alcohol- and cannabis-related positive expectancies (e.g., relaxation and tension reduction) have also been associated with higher risk outcomes in college students when examining alcohol and cannabis without taking into account other substances, such as increased alcohol consumption and increased cannabis use

frequency (e.g., Buckner et al., 2013; Ramirez et al., 2020). The current findings indicate that motives and expectancies for alcohol and cannabis co-use may not be affected by if the effects overlap (SAM use) or do not overlap (CAM use), and previous research examining alcohol- and cannabis-related motives and expectancies during single substance use are relevant to co-use days. This can be related back to the theoretical perspective of alcohol and cannabis as substitutes or complements to each other (Hursh et al., 2005). In regards to motives and expectancies, the results of the current study lend support to the perspective of the substances as substitutes to each other, as these cognitions did not vary across SAM versus CAM use days, thus they can be viewed as being used independently. This is contradictory to the complements' perspective, in which on substance is enhanced by the other (Hursh et al., 2005).

Differences in environmental context could not be examined as the analyses had errors. This could have been due to the small sample size and comparing multiple types of environmental contexts across two groups (SAM and CAM use days; Research question 2.3). Regarding social context, the likelihood of being with others and being alone did not vary across SAM or CAM use days (Research question 2.4). This finding is similar to previous research that did not find an association between SAM use and the number of people present (Lipperman-Kreda et al., 2018). However, previous studies examining alcohol or cannabis use, without regard to if they are combined with other substances, have found that college students tend to use cannabis when others are present (Phillips et al., 2018) and consume alcohol more so when they are with their friends (Braitman et al., 2017). The current study extends the finding in relation to SAM use in a sample of college students by showing that there was not a difference between SAM or CAM use days in regards other being present or not. These findings could be different from previous studies (e.g., Braitman et al., 2017; Phillips et al., 2018) because the previous

studies examined only single substance use. There were also methodological differences with the previous studies and the current study. Phillips et al. (2018) used an EMA approach, in which participants were sent surveys three times a day over a two-week period. This could have limited recall bias that may have occurred in the current study. Additionally, the current study looked at the likelihood of being with others rather than alone, which was different from previous studies that asked about number of people present during SAM use (e.g., Lipperman-Kreda et al., 2018) and more specifically who they were with on single substance use days (Braitman et al., 2017). However, all Aim 2 results (comparing cognitions and contexts across SAM versus CAM days) should be interpreted with caution, as there were only 68 cases in this examination (60 SAM use days and 8 CAM use days), which could increase Type II error. This examination was also very unbalanced, with only 11.8% of cases reflecting CAM days.

Aim 3 – SAM-Specific Consequences, Cognitions, and Contexts across Types of Alcohol and Routes of Cannabis Administration

Lastly, the current study found that SAM consequences did not vary across route of cannabis administration. This did not support Hypothesis 3.1. Previous research found that during single use sessions, cannabis concentrates were associated with negative consequences (Prince & Conner, 2019). This finding was not replicated during SAM use in the current sample of college students. However, Prince & Conner (2019) examined cannabis use in a sample of adults from Colorado with an average of 24.2 use days in the past 30 days and asked about cannabis use in one cross-sectional anonymous survey. This is different from the current study, in which college students reported an average of 8.2 SAM use days in the past 30 days. It could be that those in the Prince & Connor (2019) study were more frequent cannabis users. Additionally, Virginia just recently implemented a law that legalized simple possession of

cannabis, with caveats, such that individuals cannot distribute or sell cannabis and businesses will not be able to sell cannabis until 2024 (Cannabis Control Authority, 2021), whereas in Colorado retailers that have a license are allowed to sell cannabis products (State of Colorado, 2021). Thus, participants in the current study may not have had as much access to different routes of cannabis administration as those in Colorado, including routes of cannabis administration that have higher potency and could lead to more consequences, potentially leaving the current examination underpowered. Hypothesis 3.2 was also not supported; consequences reported on SAM use days did not vary across types of alcohol consumed. Previous research found that during single use sessions, liquor was associated with reporting more consequences (Mochrie et al., 2019). Mochrie et al. (2019) recruited only first and second year students from psychology courses. Additionally, participants only took one survey and the Rutgers Alcohol Problem Index (White & Labouvie, 1989) was used to examine alcohol-related consequences in the past year, examining between-person differences in reported consequences across beverage preferences. This was different from the current study that used items from the BYAACQ (Kahler et al., 2005) and BMCQ (Simons et al., 2012) in a daily assessment, which could have led to the current finding that these patterns were not replicated as within-person effects during SAM use. Lastly, these hypotheses may have not been supported due to the currently study being underpowered, with only 60 SAM use days across 18 participants, with a smaller number of cases for each type of alcohol or each route of cannabis administration (which were relatively unbalanced).

The analyses for Research question 3.1 (examining if the likelihood of reporting a SAM motive varied across types of alcohol) could not be examined, as the analyses were not able to run. One analysis did run for SAM motives across routes of cannabis administration, but it was

found that the likelihood of reporting the SAM motive of calm/coping did not vary across route of cannabis administration. However, it is important to remember that the current study was underpowered, thus these non-significant results may be different with more participants and more SAM use days. None of the other analyses for route of cannabis administration were able to run. Interestingly, none of the participants in the current study reported the SAM motive of conformity. This aligns with previous literature that found that young adults who reported higher SAM conformity motives were less likely to report SAM use (Patrick, Fairlie, et al., 2018). Additionally, participants in the current study did not highly endorse the conformity motive for alcohol or cannabis on any co-use day (4.4% and 4.5%, respectively). Participants may not be using alcohol and cannabis simultaneously to conform with others, because they do not feel like they need to fit in with a group (SAM motive), be left out if they do not use alcohol (alcohol motive), or to be cool (cannabis motive).

SAM expectancies did vary across type of alcohol (Research question 3.2). On SAM use days when shots (liquor) were consumed, compared to multiple types of alcohol, participants reported greater SAM expectancies ("How much does alcohol/marijuana alter this effect?"; higher score indicates that the other substance intensifies the expectancies of the first substance) on the day prior. The lack of other significant comparisons did not align with previous research in a sample of college students, which may have been due to only being able to analyze 60 SAM use days across 18 participants. Pedersen et al. (2010) found that wine was associated with the expectancy of relaxation over shots of distilled spirits. However, this differed from the current study's findings in that it only examined one substance's (alcohol) expectancies using an anonymous cross-sectional survey and used the CEOA (Fromm et al., 1993) to examine alcohol-related expectancies. Outside of these differences, the relationship between expectancies and

type of alcohol may be different on SAM use days than single use days. The second analysis for research question 3.2 (if SAM expectancies varied across route of cannabis administration) did not run successfully.

The analyses for research question 3.3 (examining if the likelihood of being in a specific location varied across type of alcohol or route of cannabis administration on SAM use days) and research question 3.4 (examining if the likelihood of being with others or not varied across type of alcohol or route of cannabis administration on SAM use days) did not run.

Implications

The results of the current study have implications for substance use prevention and intervention efforts. First, consuming multiple types of alcohol in one day was found to be the most common in regard to types of alcohol. Harm reduction education efforts for college students should focus on the risks of consuming multiple types of alcohol in one day. In addition, more alcohol was consumed on days when participants consumed liquor or caffeinated mixed beverages. Health education campaigns should address the risk factors (i.e., more consequences) associated with these beverages (e.g., Linden-Carmichael & Lau-Barraco, 2017; Mochrie et al., 2019). Additionally, specific interventions are needed for SAM use, as more consequences were experienced on SAM use days than CAM use days. To date, existing interventions address alcohol use or cannabis use, but no well-known intervention programming addresses the use of both, in particular noting increased consequences with their effects overlap. Last, motives and expectancies did not vary across SAM and CAM use days, suggesting it may be sufficient for practitioners to address specific alcohol or cannabis related motives and expectancies, without needing to address those specific to SAM use.

Limitations

The current study is not without its limitations. Notably, this study took place during the COVID-19 pandemic, and use of alcohol and cannabis (as well as their co-use) may have been different for college students during this time. White et al. (2020) found that college students consumed less alcohol after college campuses closed due to the COVID-19 pandemic, specifically among those who moved back home to live with their parents. College students were also not drinking socially with peers and reported fewer social opportunities for alcohol consumption (Jackson et al., 2021). For the current study, most participants reported that they were drinking about the same amount of alcohol (as compared to before the pandemic), however, five participants reported drinking more than usual and three participants reported drinking less than usual. Most participants reported using about the same quantity of cannabis, with three reporting more use than usual and one reporting less use than usual. Environmental context could have also been influenced by the COVID-19 pandemic. There was low endorsement for being at a bar/restaurant, which could be due to the restrictions in place during the pandemic, both by the state government and restrictions on gatherings at the host institutions where data were collected. This study should be replicated during non-pandemic times.

Additionally, the target number of participants for adequate power was not reached, even after expanding recruitment outside of the psychology research pool to other universities in the community. Participants were recruited from one regional area in Virginia, and as previously discussed, the legalization of recreational cannabis was newly implemented Summer 2021 and has caveats in terms of obtaining cannabis (Cannabis Control Authority, 2021). This could have impacted recruitment of SAM users, as participants may not have been willing to report their cannabis use, even with a NIH Certificate of Confidentiality in place. Recruitment was also

limited to multi-episode SAM users specifically (participated in SAM use at least twice in the past 14 days), as Aim 3 was focused specifically for SAM use. This could have limited recruitment of individuals who use alcohol and cannabis concurrently (rather than simultaneously), leading to only 8 CAM use days. Recruiting participants based on SAM use also restricted variability within person (29%-38%; Level 1), which is seen in the ICCs for quantity, consequences, and expectancies for use (Table 3). In other words, the multi-episode SAM use participants recruited for the current student may not have substantial variability in their use behavior (e.g., quantity, cognitions) and may reflect more homogeneity than the general SAM-using population (which may include individuals who engage in SAM use more rarely, when the opportunity arises). Additionally, participants may have felt it was a burden to participate in a study in which they needed to take 5-minute surveys for 21 consecutive days, even though previous studies have successfully completed daily diary studies up to 28 days (e.g., Sokolovsky et al., 2020). As stated previously, these results should be interpreted with caution due to the possibility of increased Type II error, especially for the aims that examined SAM and CAM use days only (n = 68 days), and cannot be generalized outside of the current sample.

In addition, due to a coding error, past 30-day cannabis use was not included as a covariate, as other studies have previously done (e.g., Jackson et al., 2020; White et al., 2019). Lastly, measurement of cannabis quantity during the daily surveys lacks a standardized measure that takes potency into consideration, as alcohol has with standard drink measures. This could have affected the non-significant findings for cannabis quantity across routes of cannabis administration and SAM versus CAM use days.

Future Research

Future research should replicate the study with more participants to obtain an adequate power. Additionally, different modes of cannabis use should be analyzed during SAM use days, such as smoking versus vaping. Further studies should also consider using an ecological momentary assessment approach, in which participants can complete surveys in the moment throughout the day, rather than thinking back to the previous day. This would reduce the chance of participants forgetting their previous day's behavior and have more accurate data. This would also allow examinations of which substance was used first and how long the effects are felt, thus being able to have a more accurate estimate of simultaneous versus concurrent use. Additionally, it would establish better temporal associations, such as cognitions (i.e., motives and expectancies) being reported before use. Finally, future research should examine the current study's aims across states with varying cannabis use laws. This would allow for direct comparisons to determine if there are any differences in outcomes based on the legality of cannabis use.

Conclusion

In conclusion, the current study sought to expand and address gaps in the literature related to co-use of alcohol and cannabis in relation to their consequences, cognitions, contexts, and type of alcohol and route of cannabis administration used. Due to a small sample size, results should be interpreted with caution. Participants most often consumed multiple types of alcohol on alcohol use days and plant on cannabis use days. Participants consumed more alcohol on days when they consumed shots (liquor), or caffeinated mixed drinks compared to multiple types of alcohol. Additionally, participants experienced more consequences on SAM use days than CAM use days. Lastly, participants had greater SAM expectancies on days when they consumed shots

(liquor) compared to multiple type of alcohol. Further research is needed with a larger sample size and during non-COVID-19 pandemic times.

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APPENDIX A

STUDY DESCRIPTION FOR SONA RECRUITMENT

Research is emerging regarding the co-use of alcohol and cannabis in college students. The current study examines simultaneous alcohol and cannabis use among college students to determine the consequences, cognitions, contexts, and types of alcohol and cannabis associated with use over 21 consecutive days.

If you decide to participate, you will complete an online baseline survey, lasting approximately 60 minutes. Questions in the baseline survey assess your alcohol and cannabis use (note, cannabis use is illegal at the federal level), including related consequences, cognitions, contexts, types, and internalizing symptoms, such as depression, stress, and anxiety. In addition, questions will be asked related to the COVID-19 pandemic. You will then be invited to complete surveys over 21 consecutive days. Links will be emailed or texted to you each morning by 9am. Each daily survey will last approximately 5 minutes. Questions in the survey will be related to your alcohol and/or cannabis use and their related consequences, cognitions, contexts, and types, as well as other health behaviors.

APPENDIX B

VIDEO SCRIPTS

Before Informed Consent

[This text appears at the very beginning of the survey, before we ask them to provide informed consent, to explain the general purpose and procedure of the study to potential participants. Each section is provided as text, and is also the audio provided during a cartoon-style video imbedded on the survey page.]

What's this study about?

This study is about alcohol and cannabis use and other health behaviors among college students. We ask about your own behaviors, attitudes, and other topics like that. We also have questions about who you are. We want to help students be smart about their alcohol and cannabis use.

This study is not anonymous. We ask for your name and email, or other ways to contact you. We need to know who you are so that: 1) we can compensate you for participating in the study, and 2) we can link your responses across the survey you complete today and over 21 consecutive days. BUT we will only report summaries across everyone (like average use across all participants in the study), and we will never disclose who said what. We also have a Certificate of Confidentiality from the National Institutes of Health. This means that if parents, school officials, police officers, or other officials try to ask us to share our data, we won't. This certificate gives us the right to refuse any requests for your information.

Also, in addition to the activities you complete today, your participation today will make you eligible for the daily survey portion of the study, in which you could earn additional course credit and money (but more on that later).

To be eligible for the study, you must meet the following criteria:

You must be able to read and understand English to participate in this study. You must also have daily access to a device that connects to the internet to complete the surveys. You must be between the ages of 18-25 years old, be currently enrolled in classes at the time of the study, and have participated in simultaneous alcohol and cannabis use (so that their effects overlap) at least twice in the past 14 days prior to enrolling in the study. In addition, the information provided in the daily surveys are critical to our research. It's very important to us to have high quality data, meaning people are answering each question to the best of their ability. So we have some items in the survey that check if people are paying attention. To be enrolled in the daily surveys, you must correctly answer 3 or more (out of 4) questions in the baseline survey that check to make sure you are reading the questions in their entirety.

How does today work?

First, you'll read the informed consent. It tells you a lot of the same information as in this video, plus your rights as a research participant, and who you can contact if you have questions or complaints. If you agree to participate, you'll click the arrow at the bottom of the form to move on to the baseline survey. You may print a copy of the informed consent for yourself if you wish to do so.

Next, you'll complete a survey on your device.

In the survey, we'll ask for your ODU email address. The links to the daily surveys and reminders will be sent to the email address you provide. You can also choose to provide your cell phone number to receive text message reminders for the daily surveys.
When you finish the survey, you'll be directed to a video with instructions for the daily surveys. Everything you do today will take about an hour in total.
You'll get 1 Sona credit for completing today's baseline survey, and we'll put that in the Sona system within a week of you completing the survey.

What happens after the study?

Participants who are eligible for Sona credit and choose this option have their choice of two options for compensation. If there are at least three weeks left during the Sona period, you can earn up to an additional 3 research credits and a $25 Amazon gift card by completing the daily surveys. If you prefer monetary compensation or there are not at least three weeks left during the Sona period, you can earn up to an additional $21.75 by completing the daily surveys. All other participants can earn up to an additional $21.75 by completing the daily surveys. The surveys are critical for our research, and your participation in these surveys are incredibly helpful. The good news is the follow up surveys are shorter than the survey you will take today. Each daily survey should only take about 5 minutes.
After verifying eligibility, you will receive an email from the researcher within 3 days to see when you would like the daily surveys to begin. The daily surveys will be sent to you at 9am beginning on the day you choose. The email will have a link to the first daily survey, which will ask about your substance use the previous day and for later that day, as well as other behaviors. You will continue to get these emails for 20 more consecutive days, for a total of 21 days. The daily surveys should be completed by 2pm that day, however, you can complete the survey up until your next daily survey is sent (at 9am the following day). You will receive reminders via emails and/or text message if you do not complete three consecutive daily surveys.
Participants who are eligible for Sona credit and choose this option will receive Sona credit based on the amount of daily surveys you complete. If you complete 0 days of surveys, you will receive 0 Sona credits. Completing 1-2 days of surveys gets you 0.5 Sona credits. Completing 3-6 daily surveys gets you 1 Sona credit, 7-10 days get you 1.5 Sona credits, 11-14 days gets you 2.0 Sona credits, 15-17 days gets you 2.5 Sona credits, and 18-21 days gets you 3 Sona credits. In addition to these Sona credits you earn, if you complete at least 85% of the daily surveys (at least 18 daily surveys), you will be entered into a raffle for one of four $25 Amazon Gift Cards. All of this is on top of the 1 Sona credit you earned today by completing the baseline survey.
Those who are eligible for Sona credit but choose gift card compensation, or those who enroll in the daily surveys after the deadline to earn Sona credit, or participants not involved in Sona will receive monetary compensation in the form of Amazon gift cards based on the amount of daily surveys you complete. For each daily survey you complete, you will earn 75 cents (or $15.75 total for all surveys).
If you complete at least 85% of the daily surveys (at least 18 daily surveys), you will receive an additional $6. For those that chose Sona credit for baseline but gift card compensation for the daily surveys and you complete all of the daily surveys and earn the bonus, then you will receive a total of $21.75. For those that chose gift card compensation for all parts of the study, all of this is on top of the $5 you earned today by completing the baseline survey. So if you complete

today's survey plus all 21 daily surveys and earn the bonus, then you will receive a total of $26.75.
The daily surveys will take about 5 minutes each.

After Baseline

[This text appears at the end of the baseline survey, and is also the audio provided during a cartoon-style video imbedded on the survey page for participants]

Daily Surveys

If you are eligible for Sona credit and are choosing that option for your compensation (up to 3 more credits), please watch this video:
As a reminder, you can earn up to an additional 3 research credits and a $25 Amazon gift card by completing the daily surveys. The surveys are critical for our research, and your participation in these surveys are incredibly helpful. The good news is the follow up surveys are shorter than the survey you took today.
You will receive an email at 9am the day after you complete the baseline survey (unless you complete it on a Friday or Saturday, then you will receive an email on Monday). The email or text message will have a link to the first daily survey, which will ask about your substance use the previous day and other behaviors. You will continue to get these emails for 20 more consecutive days, for a total of 21 days. The daily surveys should be completed by 2pm that day, however, you can complete the survey up until 8:59am the following day. You will receive reminders via emails and/or text message if you do not complete three consecutive daily surveys. You will receive research credit based on the amount of daily surveys you complete. If you complete 0 days of surveys, you will receive 0 Sona credits. Completing 1-2 days of surveys gets you 0.5 Sona credits). Completing 3-6 daily surveys gets you 1 Sona credit, 7-10 days gets you 1.5 Sona credits, 11-14 days gets you 2.0 Sona credits, 15-17 days get you 2.5 Sona credits, and 18-21 days gets you 3 Sona credits. In addition to these Sona credits you earn, if you complete at least 85% of the daily surveys (at least 18 daily surveys), you will be entered into a raffle for one of four $25 Amazon Gift Cards. All of this is on top of the 1 Sona credit you earned today by completing the baseline survey.
The daily surveys will take about 5 minutes each.
[audio/video only] If you have any questions about this research study now or in the future, please contact the researchers using the contact information provided on this page. If at any time you feel pressured to participate, or if you have any questions about your rights or this form, then you should call Dr. Tancy Vandecar-Burdin, the current IRB chair or the Old Dominion University Office of Research, using the phone numbers provided on this page.
[written only] If you have any questions about this research study now or in the future, please contact the co-investigator, Jennifer Shipley, M.P.H., at jship002@odu.edu or the principal investigator, Abby L. Braitman, Ph.D., at abraitma@odu.edu. If at any time you feel pressured to participate, or if you have any questions about your rights or this form, then you should call Dr. Tancy Vandecar-Burdin, the current IRB chair, at 757-683-3802, or the Old Dominion University Office of Research, at 757-683-3460.
If you are not eligible for Sona credit or are choosing monetary compensation (up to $21.75 more), please watch this video:

As a reminder, you can earn an additional 75 cents for each daily survey, or up to an additional $21.75 by completing all the daily surveys. The surveys are critical for our research, and your participation in these surveys are incredibly helpful. The good news is the daily surveys are much shorter than the survey you took today.

After verifying eligibility, you will receive an email from the researcher within 3 days to see when you would like the daily surveys to begin. The daily surveys will be sent to you at 9am beginning on the day you choose. The email will have a link to the first daily survey, which will ask about your substance use the previous day and for later that day, as well as other behaviors. You will continue to get these emails for 20 more consecutive days, for a total of 21 days. The daily surveys should be completed by 2pm that day, however, you can complete the survey up until 8:59am the following day. You will receive reminders via emails and/or text message if you do not complete three consecutive daily surveys.

For each daily survey you complete, you will earn 75 cents (or $15.75 total). If you complete at least 85% of the daily surveys (at least 18 daily surveys), you will receive an additional $6. For those that chose Sona credit for baseline but gift card compensation for the daily surveys and you complete all of the daily surveys and earn the bonus, then you will receive a total of $21.75. For those that chose gift card compensation for all parts of the study, all of this is on top of the $5 you earned today by completing the baseline survey. So if you complete today's survey plus all 21 daily surveys and earn the bonus, then you will receive a total of $26.75.

The daily surveys will take about 5 minutes each.

[audio/video only] If you have any questions about this research study now or in the future, please contact the researchers using the contact information provided on this page. If at any time you feel pressured to participate, or if you have any questions about your rights, then you should call Dr. Tancy Vandecar-Burdin, the current IRB chair or the Old Dominion University Office of Research, using the phone numbers provided on this page.

[written only] If you have any questions about this research study now or in the future, please contact the co-investigator, Jennifer Shipley, M.P.H., at jship002@odu.edu or the principal investigator, Abby L. Braitman, Ph.D., at abraitma@odu.edu. If at any time you feel pressured to participate, or if you have any questions about your rights or this form, then you should call Dr. Tancy Vandecar-Burdin, the current IRB chair, at 757-683-3802, or the Old Dominion University Office of Research, at 757-683-3460.

APPENDIX C

EMAILS TO PARTICIPANTS

Email with Baseline Survey Link

Hello,

Based on your responses, you are eligible to participate in our study. If you decide to participate, then you will be redirected the baseline survey now. The baseline survey will take approximately 60 minutes to complete. At the end of the survey, you will select if you would like to receive Sona credit (only students enrolled at ODU in psychology courses) or monetary compensation. For those that choose Sona credit, you will receive 1 Sona research credit for completing it (after verifying eligibility). Everyone else will receive $5 for completing today's survey (after verifying eligibility).

If eligible, you will be invited to complete the daily surveys, in which you can receive up to 3 additional research credits for completing 21 days of the daily surveys. For those who are eligible for Sona credits and choose this option, compensation for the daily surveys is as follows: 0 days (0 credits), 1-2 days (.5 credits), 3-6 days (1 credits), 7-10 days (1.5 credits), 11-14 days (2.0 credits), 15-17 days (2.5 credits), and 18-21 days (3 credits). In addition, if you complete at least 85% of the daily surveys (at least 18 daily surveys), you will be entered into a raffle for one of four $25 Amazon Gift Cards.

Everyone outside of the Sona system or those who choose monetary compensation can receive up to an additional $21.75 for completing 21 days of the daily surveys. For each daily survey you complete, you will earn 75 cents. If you complete at least 85% of the daily surveys (at least 18 daily surveys), you will receive an additional $6.

Click here to begin the baseline survey:

If you have any questions, please contact Jennifer Shipley at jship002@odu.edu.

Sincerely,

Jennifer

Jennifer Shipley, MPH
Graduate Student
Health Psychology Doctoral Program
Old Dominion University
Pronouns: she, her, hers

Follow up Emails to Participants after Baseline

[First email if participants meet eligibility criteria - Sona]

Hello [insert name of participant],

Thank you for completing the baseline survey for the Simultaneous Alcohol and Cannabis Use in College Students study. Participants like you are crucial for our research, and we appreciate your participation. Below is a list of dates in the upcoming week. Please reply to this email with the date that you would like your daily surveys to begin. The date you pick will need to be at least 48 hours away (for example, if you would like your surveys to begin on a Sunday, let me know by Friday at 9am). As a reminder, surveys will be sent at 9am for 21 consecutive days. We ask that surveys be completed between 9am and 2pm to best remember your behaviors for the previous day. The link will stay open until 9am tomorrow.

Remember, you receive Sona credit based on the number of daily surveys you complete, and there is a bonus raffle for participants who complete at least 18 of the daily surveys. Thank you for helping us with our research!

[list dates here]

Sincerely,

Jennifer

Jennifer Shipley, MPH
Graduate Student
Health Psychology Doctoral Program
Old Dominion University
Pronouns: she, her, hers

[First email if participants meet eligibility criteria – non-Sona]

Hello [insert name of participant],

Thank you for completing the baseline survey for the Simultaneous Alcohol and Cannabis Use in College Students study. Participants like you are crucial for our research, and we appreciate your participation. Below is a list of dates in the upcoming week. Please reply to this email with the date that you would like your daily surveys to begin. The date you pick will need to be at least 48 hours away (for example, if you would like your surveys to begin on a Sunday, let me know by Friday at 9am). As a reminder, surveys will be sent at 9am for 21 consecutive days. We ask that surveys be completed between 9am and 2pm to best remember your behaviors for the previous day. The link will stay open until 9am tomorrow.

Remember, you receive 75 cents for each daily survey you complete, and there is a $6 bonus for participants who complete at least 18 of the daily surveys. Thank you for helping us with our research!

[list dates here]

Sincerely,

Jennifer

Jennifer Shipley, MPH

Graduate Student
Health Psychology Doctoral Program
Old Dominion University
Pronouns: she, her, hers

[First email if participants enrolled in daily surveys - Sona]

Hello [insert name of participant],

Thank you for completing the baseline survey for the Simultaneous Alcohol and Cannabis Use in College Students study. Participants like you are crucial for our research, and we appreciate your participation. Below is the link for today's survey. Please note that the link below only works for today and you can only complete it once. Please complete this survey between 9am and 2pm today to best remember your behaviors yesterday. The link will stay open until 9am tomorrow.

Remember, you receive Sona credit based on the number of daily surveys you complete, and there is a bonus raffle for participants who complete at least 18 of the daily surveys. Thank you for helping us with our research!

[Insert link here]

Sincerely,

Jennifer

Jennifer Shipley, MPH
Graduate Student
Health Psychology Doctoral Program
Old Dominion University
Pronouns: she, her, hers

[First email if participants enrolled in daily surveys – non-Sona]

Hello [insert name of participant],

Thank you for completing the baseline survey for the Simultaneous Alcohol and Cannabis Use in College Students study. Participants like you are crucial for our research, and we appreciate your participation. Below is the link for today's survey. Please note that the link below only works for today and you can only complete it once. Please complete this survey between 9am and 2pm today to best remember your behaviors yesterday. The link will stay open until 9am tomorrow.

Remember, you receive 75 cents for each daily survey you complete, and an additional $6 for completing at least 18 of the daily surveys. So you can earn a total of $21.75 by completing all 21 daily surveys, delivered as an Amazon gift card. Thank you for helping us with our research!

[Insert link here]

Sincerely,

Jennifer

Jennifer Shipley, MPH
Graduate Student
Health Psychology Doctoral Program
Old Dominion University
Pronouns: she, her, hers

[Email to participants for daily surveys 2-21 - Sona]

Hello [insert name of participant],

Thank you continuing to participate in the Simultaneous Alcohol and Cannabis Use in College Students study. Participants like you are crucial for our research, and we appreciate your participation. Below is the link for today's survey. Please note that the link below only works for today and you can only complete it once. Please complete this survey between 9am and 2pm today to best remember your behaviors yesterday. The link will stay open until 9am tomorrow.

Remember, you receive Sona credit based on the number of daily surveys you complete, and there is a bonus raffle for participants who complete at least 18 of the daily surveys. Thank you for helping us with our research!

[Insert link here]

Sincerely,

Jennifer

Jennifer Shipley, MPH
Graduate Student
Health Psychology Doctoral Program
Old Dominion University
Pronouns: she, her, hers

[Email to participants for daily surveys 2-21 – non-Sona]

Hello [insert name of participant],

Thank you continuing to participate in the Simultaneous Alcohol and Cannabis Use in College Students study. Participants like you are crucial for our research, and we appreciate your participation. Below is the link for today's survey. Please note that the link below only works for today and you can only complete it once. Please complete this survey between 9am and 2pm today to best remember your behaviors yesterday. The link will stay open until 9am tomorrow.

Remember, you receive 75 cents for each daily survey you complete, and an additional $6 for completing at least 18 of the daily surveys. So you can earn a total of $21.75 by completing all 21 daily surveys, delivered as an Amazon gift card. Thank you for helping us with our research!

[Insert link here]

Sincerely,

Jennifer

Jennifer Shipley, MPH
Graduate Student
Health Psychology Doctoral Program
Old Dominion University
Pronouns: she, her, hers

[Email reminder to daily survey participants who miss 3 consecutive daily surveys – Sona only]

Hello [insert name of participant],

This is a reminder that you are enrolled in the Simultaneous Alcohol and Cannabis Use in College Students study. We noticed you have missed 3 consecutive daily surveys. Please complete the daily survey between 9am and 2pm to best remember your behaviors yesterday. The link will stay open until 9am the next day. If you have any questions or concerns about the study, please email Jennifer Shipley at jship002@odu.edu.

Remember, you receive Sona credit based on the number of daily surveys you complete, and there is a bonus raffle for participants with high compliance. Thank you for helping us with our research!

Sincerely,

Jennifer

Jennifer Shipley, MPH
Graduate Student
Health Psychology Doctoral Program
Old Dominion University
Pronouns: she, her, hers

[Email reminder to daily survey participants who miss 3 consecutive daily surveys – non-Sona]

Hello [insert name of participant],

This is a reminder that you are enrolled in the Simultaneous Alcohol and Cannabis Use in College Students study. We noticed you have missed 3 consecutive daily surveys. Please complete the daily survey between 9am and 2pm to best remember your behaviors yesterday. The link will stay open until 9am the next day. If you have any questions or concerns about the study, please email Jennifer Shipley at jship002@odu.edu.

Remember, you receive compensation based on the number of daily surveys you complete (75 cents per survey), and participants with high compliance can earn an additional $6. Thank you for helping us with our research!

Sincerely,

Jennifer

Jennifer Shipley, MPH
Graduate Student
Health Psychology Doctoral Program
Old Dominion University
Pronouns: she, her, hers

[Text message reminder to daily survey participants who miss 3 consecutive daily surveys]

This is a reminder that you are enrolled in the Simultaneous Alcohol and Cannabis Use in College Students study. Please complete the daily survey between 9am and 2pm to best remember your behaviors yesterday. The link will stay open until 9am the next day. Questions? Email Jennifer Shipley at jship002@odu.edu.

[Email to participants if they do not meet the eligibility criteria and are not enrolled in daily surveys – Sona only]

Hello [insert name of participant],

Thank you for completing the baseline survey for the Simultaneous Alcohol and Cannabis Use in College Students study. Based on the eligibility criteria of the study, you are not eligible to continue on to the daily survey portion and you will not receive 1 Sona credit for your participation so far. If you have any questions, please email Jennifer Shipley at jship002@odu.edu

Sincerely,

Jennifer

Jennifer Shipley, MPH,
Graduate Student
Health Psychology Doctoral Program
Old Dominion University
Pronouns: she, her, hers

[Email to participants if they do not meet the eligibility criteria in the baseline survey – non-Sona]

Hello [insert name of participant],

Thank you for completing the baseline survey for the Simultaneous Alcohol and Cannabis Use in College Students study. Based on the eligibility criteria of the study and the information provided in the baseline survey, you are not eligible for the study and you will not receive $5 your participation so far. If you have any questions, please email Jennifer Shipley at jship002@odu.edu

Sincerely,

Jennifer

Jennifer Shipley, MPH
Graduate Student
Health Psychology Doctoral Program
Old Dominion University
Pronouns: she, her, hers

[Email to participants who win one of the four $25 Amazon gift cards – Sona only]

Hello [insert name of participant],

Thank you for completing the Simultaneous Alcohol and Cannabis Use in College Students study. You have won a $25 Amazon gift card! The gift card will be emailed to you at this same email address, but will come directly from Amazon. Please check your junk/spam folders if you do not see this email within the next 24 hours. If you have any questions, please email Jennifer Shipley at jship002@odu.edu

Sincerely,

Jennifer

Jennifer Shipley, MPH
Graduate Student
Health Psychology Doctoral Program
Old Dominion University
Pronouns: she, her, hers

[Email to non-Sona participants who complete baseline]

Hello [insert name of participant],

Thank you for completing the Simultaneous Alcohol and Cannabis Use in College Students study baseline survey. You have earned a $5 Amazon gift card! The gift card will be emailed to you at this same email address, but will come directly from Amazon. Please check your junk/spam folders if you do not see this email within the next 24 hours. If you have any questions, please email Jennifer Shipley at jship002@odu.edu

Sincerely,

Jennifer

Jennifer Shipley, MPH
Graduate Student
Health Psychology Doctoral Program
Old Dominion University
Pronouns: she, her, hers

[Email to non-Sona participants who complete daily surveys]

Hello [insert name of participant],

Thank you for completing the Simultaneous Alcohol and Cannabis Use in College Students study. You have earned a $X (to be filled in with the amount based on the daily surveys) Amazon gift card for completing the daily surveys! The gift card will be emailed to you at this same email address, but will come directly from Amazon. Please check your junk/spam folders if you do not see this email within the next 24 hours. If you have any questions, please email Jennifer Shipley at jship002@odu.edu

Sincerely,

Jennifer

Jennifer Shipley, MPH
Graduate Student
Health Psychology Doctoral Program
Old Dominion University
Pronouns: she, her, hers

[Email to non-Sona participants who complete daily surveys + bonus]

Hello [insert name of participant],

Thank you for completing the Simultaneous Alcohol and Cannabis Use in College Students study. You have earned a $X (to be filled in with the amount based on the daily surveys) Amazon gift card for completing the daily surveys plus a bonus! The gift card will be emailed to you at this same email address, but will come directly from Amazon. Please check your junk/spam folders if you do not see this email within the next 24 hours. If you have any questions, please email Jennifer Shipley at jship002@odu.edu

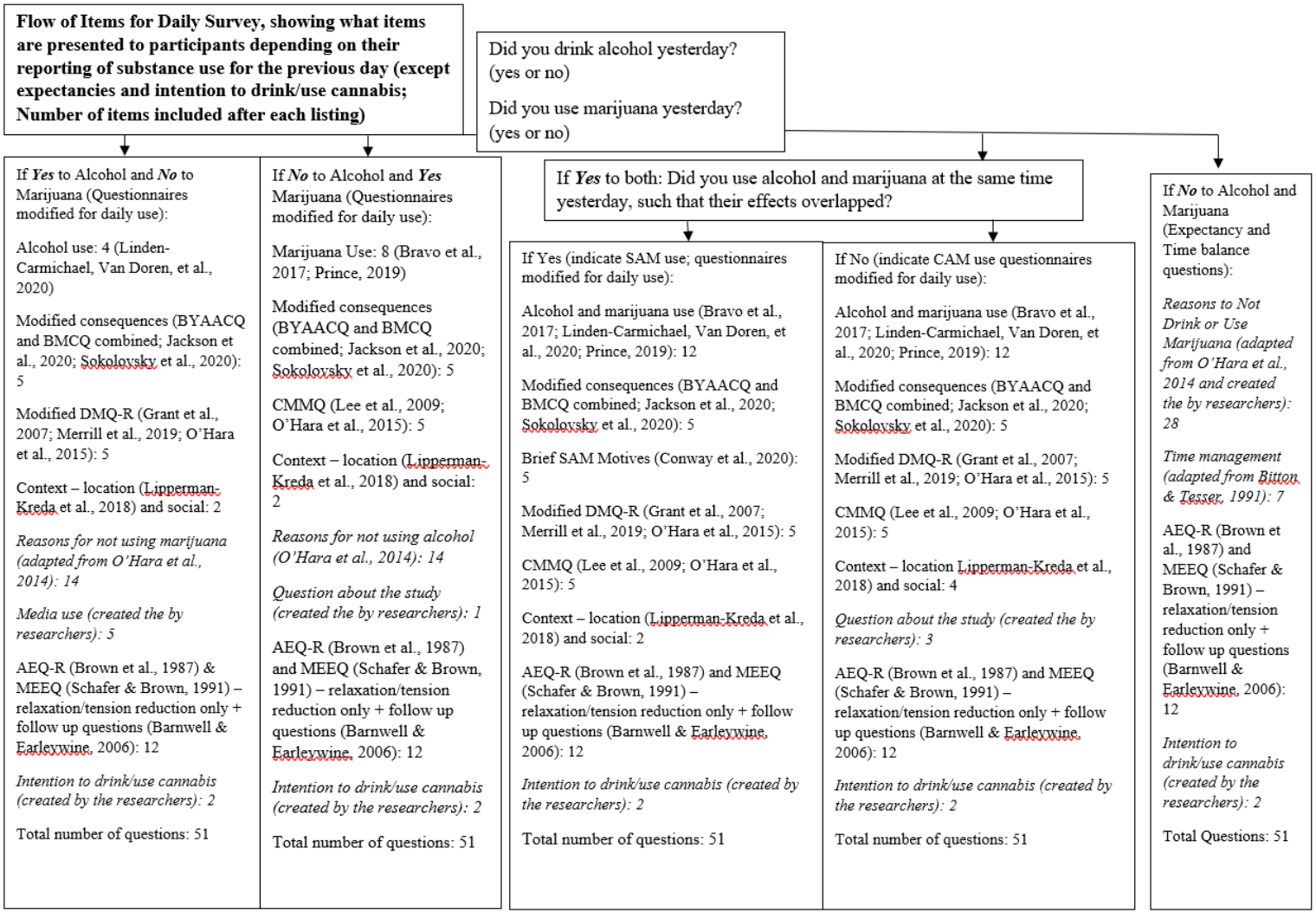
Sincerely,

Jennifer

Jennifer Shipley, MPH
Graduate Student
Health Psychology Doctoral Program
Old Dominion University
Pronouns: she, her, hers

APPENDIX D

FLOW OF ITEMS FOR DAILY SURVEY



APPENDIX E

ALCOHOL USE - BASELINE

Did you consume alcohol within the previous 30-days?

- Yes
- No

On how many days of the past 30-days did you consume alcohol? (dropdown options; range from 0-30)

APPENDIX F

DAILY ASSESSMENT: SUBSTANCE USE

The following questions are related to yesterday (the time period from when you woke up until you went to sleep the day before today):

1. Did you drink alcohol yesterday?

- Yes
- No

2. Did you use marijuana yesterday?

- Yes
- No

3. Did you use alcohol and marijuana at the same time yesterday, such that their effects overlapped?

- Yes
- No

APPENDIX G

DAILY ALCOHOL QUANTITY

For all questions that ask, standard drinks will be equal to:

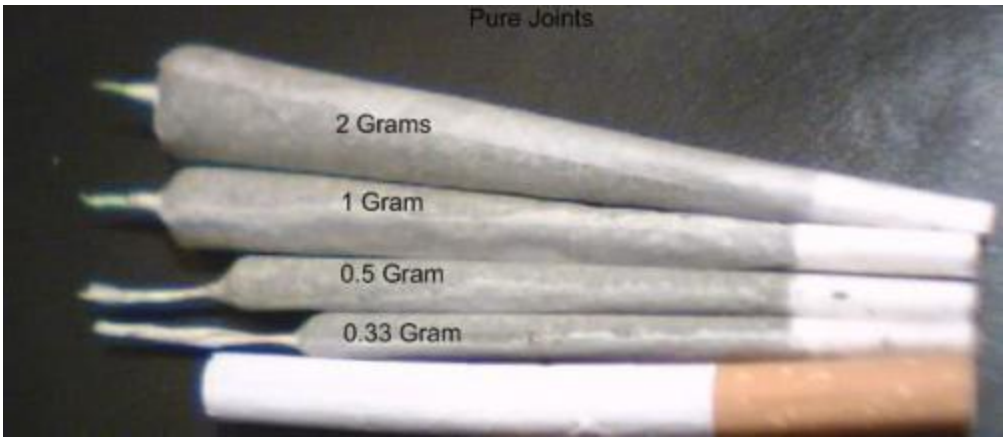
- 12 oz of hard seltzer at 5% alcohol
- 12 oz of regular beer at 5% alcohol
- 8-9 oz of craft beer at about 7% alcohol
- 4-5 oz of wine at about 13% alcohol
- 1.5 oz of liquor in a mixed drink at 40% alcohol
- 1.5 oz of 80 proof liquor at 40% alcohol

1. How many standard drinks did you consume yesterday? (dropdown menu; 0-30+)

APPENDIX H

DAILY CANNABIS QUANTITY

The following images and descriptions are for the next question.



5. What is the estimated amount of marijuana you used yesterday (in grams)? (dropdown menu; less than 0.25 -5+ grams, in .25g increments)

6. How confident are you in the amount of marijuana you reported you used yesterday? (dropdown menu; 0 = not at all confident – 10 = completely confident)?

APPENDIX I

DAILY ASSESSMENT: ALCOHOL

[If Yes for Alcohol use]

Which types of alcohol did you consume yesterday? *Check all that apply*

[ ] Beer

[ ] Hard cider

[ ] Wine

[ ] Mixed drinks (liquor)

[ ] Hard seltzer

[ ] Shots (liquor)

[ ] Other (Please describe): _____

[If mixed drinks are selected] Did you consume alcohol mixed with caffeinated beverages in the past 30-days?

- Yes
- No

APPENDIX J

DAILY ASSESSMENT: CANNABIS ROUTE OF ADMINISTRATION

[If Yes for Cannabis use]

Which types of marijuana did you use yesterday? *Select all that apply*

[ ] Plant (e.g., smoking bud, flower)

[ ] Edibles (e.g., brownie, chocolate)

[ ] Concentrates (e.g., hash, dabs)

[ ] Topicals

[ ] Other (Please describe): _____

APPENDIX K

SIMULTANEOUS USE AT BASELINE – ELIGIBILITY CHECK

How many days in the past 14 days did you use alcohol and marijuana at the same time **so that their effects overlapped**? (dropdown menu; range from 0-30+)

APPENDIX L

SAM-RELATED NEGATIVE CONSEQUENCES

[The full measure is shown below, with a strikethrough for items that have been removed]

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 yesterday.

	Yes, due to alcohol use alone	Yes, due to marijuana use alone	Yes, due to using alcohol and marijuana so that their effect overlapped	No, I have not experienced this as a result of my alcohol and/or marijuana use
1. Had a hangover or felt in a fog this morning after I had been using yesterday				
~~2. My school work has suffered because of my use~~				
~~3. I had less energy or felt tired because of my use~~				
~~4. Have often ended up using on nights when I had planned not to use~~				
~~5. While using, I have said or done embarrassing things~~				
~~6. Have missed classes because of use, a hangover, or illness caused by use~~				
~~7. When using, I have done impulsive things I regretted later~~				
~~8. My use has created problems between myself and my romantic partner or parents~~				
~~9. Have felt like I needed to use after I'd gotten up (i.e., before breakfast)~~				
~~10. Have neglected my obligations to my family, work, or school because of my use~~				
~~11. Have often found it difficult to limit how much I use~~				

12. Have become very rude, obnoxious, or insulting after use				
~~13. Have felt very sick to my stomach or thrown up after using~~				
~~14. Have taken foolish risks when I have been using~~				
~~15. Have passed out from using~~				
~~16. Could no longer get high on the amount that used to get me high~~				
17. My use has gotten me into sexual situations that I later regretted				
~~18. Have woken up in an unexpected place after using heavily~~				
~~19. Have driven a car while under the influence~~				
~~20. Have gotten into physical fights because of my use~~				
~~21. Have been less physically active because of my use~~				
~~22. Have had trouble sleeping after stopping or cutting down on use~~				
23. Awoke today and found I could not remember a part of the evening yesterday				
~~24. Haven't been as sharp mentally because of my use~~				
~~25. Have received a lower grade on an exam or paper than I normally would have because of my use~~				
~~26. Have tried to quit using because I thought I was using too much~~				
~~27. Have felt anxious, irritable, lost my appetite or had stomach pains after stopping or cutting down use~~				
~~28. Have lost motivation to do things because of my use~~				

APPENDIX M

CAM-RELATED NEGATIVE CONSEQUENCES

[The full measure is shown below, with a strikethrough for items that have been removed]

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 and/or your marijuana use yesterday. *Check all that apply*

	Yes, due to alcohol use alone	Yes, due to marijuana use alone	No, I have not experienced this as a result of my alcohol and/or marijuana use
1. Had a hangover or felt in a fog this morning after I had been using yesterday			
~~2. My school work has suffered because of my use~~			
~~3. I had less energy or felt tired because of my use~~			
~~4. Have often ended up using on nights when I had planned not to use~~			
~~5. While using, I have said or done embarrassing things~~			
~~6. Have missed classes because of use, a hangover, or illness caused by use~~			
~~7. When using, I have done impulsive things I regretted later~~			
~~8. My use has created problems between myself and my romantic partner or parents~~			
~~9. Have felt like I needed to use after I'd gotten up (i.e., before breakfast)~~			
~~10. Have neglected my obligations to my family, work, or school because of my use~~			
~~11. Have often found it difficult to limit how much I use~~			
12. Have become very rude, obnoxious, or insulting after use			
~~13. Have felt very sick to my stomach or thrown up after using~~			

~~14. Have taken foolish risks when I have been using~~			
~~15. Have passed out from using~~			
~~16. Could no longer get high on the amount that used to get me high~~			
17. My use has gotten me into sexual situations that I later regretted			
~~18. Have woken up in an unexpected place after using heavily~~			
~~19. Have driven a car while under the influence~~			
~~20. Have gotten into physical fights because of my use~~			
~~21. Have been less physically active because of my use~~			
~~22. Have had trouble sleeping after stopping or cutting down on use~~			
23. Awoke today and found I could not remember a part of the evening yesterday			
~~24. Haven't been as sharp mentally because of my use~~			
~~25. Have received a lower grade on an exam or paper than I normally would have because of my use~~			
~~26. Have tried to quit using because I thought I was using too much~~			
~~27. Have felt anxious, irritable, lost my appetite or had stomach pains after stopping or cutting down use~~			
~~28. Have lost motivation to do things because of my use~~			

APPENDIX N

ALCOHOL-RELATED MOTIVES

The following are a list of reasons people sometimes give for drinking alcohol. Why did you drink last night?

	0=No	1=Yes
1. To feel less nervous/anxious		
2. To feel less depressed		
3. To make the day/night more fun		
4. To get high, buzzed, or drunk		
5. To not be left out		

APPENDIX O

COMPREHENSIVE MARIJUANA MOTIVES QUESTIONNAIRE

[The full measure is shown below, with a strikethrough for items that have been removed]

This is a list of reasons people sometimes give for using marijuana. Thinking of all the times you have used marijuana, how often would you say that you use for each of the following reasons?

	0=No	1=Yes
~~Because you were under the influence of alcohol~~		
~~Because it is readily available~~		
~~To relieve boredom~~		
~~Because it was a special day~~		
~~Because you felt peer pressure from others who do it~~		
~~Because you were depressed~~		
~~Because it is fun~~		
To be cool		
~~Because there are low health risks~~		
~~To allow you to think differently~~		
Because it is there and you had nothing better to do (two items combined)		
To celebrate		
To forget your problems		
To enjoy the effects of it		
~~Because you want to alter your perspective~~		
~~Because you can get it for free~~		
~~Because you wanted something to do~~		
~~Because you didn't want to be the only one not doing it~~		
~~To escape from your life~~		
~~To see what it felt like~~		
~~Because it is not a dangerous drug~~		
~~To help you sleep~~		
~~Because it was a special occasion~~		
~~Because you were experimenting~~		
~~Because it makes you more comfortable in an unfamiliar way~~		
~~Select 3 = Half of the time for this item~~		
~~Because you had gotten drunk and weren't thinking about what you were doing~~		
~~Because it is safer than drinking alcohol~~		
~~Because you are having problems sleeping~~		

~~Because it relaxes you when you are in an insecure situation~~		
~~Because you were drunk~~		
~~So you can look at the world differently~~		
~~To feel good~~		
~~Because it helps make napping easier and enjoyable~~		
~~To make you feel more confident~~		

APPENDIX P

SAM-RELATED MOTIVES

[The full measure is shown below, with a strikethrough for items that have been removed]

The following are a list of reasons people sometimes give for using alcohol and marijuana simultaneously, or at the same time so that their effects overlap. Why did you use alcohol and marijuana simultaneously yesterday?

	0=No	1=Yes
~~Cross-faded effects are better~~		
To increase the positive effects I get from alcohol		
To increase the positive effects I get from marijuana		
To calm me down		
~~To cope with anxiety~~		
As a way to celebrate		
~~So that others won't kid me about not using~~		
~~Because it is customary on special occasions~~		
~~Because it makes special occasions more enjoyable~~		
To fit in with a group I like		
~~Pressure from others~~		

APPENDIX Q

ALCOHOL EXPECTANCY QUESTIONNAIRE

[The full measure is shown below, with a strikethrough for items that have been removed]

What are you expecting or anticipating will happen IF you drink alcohol later today? (please answer as if you were going to drink alcohol, even if that is not your intention)

	Yes, I am expecting this	No, I am not expecting this
~~Alcohol helps me sleep better~~		
~~Alcohol decreases muscular tension.~~		
~~After a few drinks I am usually in a~~Alcohol helps me to be in a better mood.		
If I am tense or anxious, ~~having a few drinks~~alcohol make~~s~~ me feel better.		
~~Alcohol enables me to fall asleep more easily~~		
~~Alcohol can act as an anesthetic; that is, it can deaden pain~~		
~~I feel like more of a happy-go-lucky person when I drink.~~		
Drinking ~~makes get-togethers~~ makes a social gathering more fun.		
~~If I am cold, having a few drinks will give me a sense of warmth.~~		

[Whichever statements receive an affirmative answer, a follow up question will be asked]
How does marijuana alter this effect (-3 = makes it less intense to 3 = makes it more intense)?

[Whichever statements don't receive an affirmative answer, a follow up question will be asked]
How does drinking more alcohol alter this effect (-3 = make it less intense to 3 = make it more intense)

APPENDIX R

CANNABIS-RELATED EXPECTANCIES

[The full measure is shown below, with a strikethrough for items that have been removed]

What are you expecting or anticipating will happen IF you use marijuana later today? (please answer as if you were going to use marijuana, even if that is not your intention)

	Yes, I am expecting this	No, I am not expecting this
~~I get a sense of relaxation from smoking marijuana.~~		
Using marijuana will make me less tense or relieve anxiety; it help~~s~~ me to unwind.		
~~Marijuana makes me carefree and I do not care about my problems as much.~~		
~~I am not concerned about how others evaluate me when I am on marijuana.~~		
~~When I use marijuana I do not feel insecure.~~		
Marijuana will make it easier to escape from/care less about problems and responsibilities.		
~~Marijuana makes me calm.~~		
I am more relaxed in social situations ~~if I've been~~ after using marijuana and do not feel insecure		
~~I get a sense of relaxation from smoking marijuana.~~		

[Whichever statements receive an affirmative answer, a follow up question will be asked]
How does alcohol alter this effect? (-3 = make it less intense to 3 = makes it more intense)?
[Whichever statements don't receive an affirmative answer, a follow up question will be asked]
How does using more marijuana alter this effect? (-3 = make it less intense to 3 = make it more intense)

APPENDIX S

SAM CONTEXTS: ENVIRONMENTAL AND SOCIAL

1. Yesterday, where were you using alcohol and marijuana simultaneously, so that their effects overlapped? *Check all that apply*

[ ] Own home/apartment/dorm
[ ] Someone else's home/apartment/dorm
[ ] Bar/restaurant
[ ] Outdoor/public place
[ ] Car or other enclosed motor vehicle
[ ] Other (Please describe): _____

2. Yesterday, were others present when you used alcohol and marijuana simultaneously?

- Yes
- No

APPENDIX T

ALCOHOL CONTEXTS: ENVIRONMENTAL AND SOCIAL (ALCOHOL ONLY DAYS/CAM USE DAYS)

1. Yesterday, where were you drinking alcohol? *Check all that apply*

[ ] Own home/apartment/dorm
[ ] Someone else's home/apartment/dorm
[ ] Bar/restaurant
[ ] Outdoor/public place
[ ] Car or other enclosed motor vehicle
[ ] Other (Please describe): _____

2. Yesterday, were others present when you were drinking alcohol?

- Yes
- No

APPENDIX U

CANNABIS USE CONTEXTS: ENVIRONMENTAL AND SOCIAL (CANNABIS ONLY DAYS/CAM USE DAYS)

Yesterday, where were you using marijuana? *Check all that apply*
[ ] Own home/apartment/dorm
[ ] Someone else's home/apartment/dorm
[ ] Bar/restaurant
[ ] Outdoor/public place
[ ] Car or other enclosed motor vehicle
[ ] Other (Please describe): _____
Yesterday, were others present when you used marijuana?

- Yes
- No

APPENDIX V

TIME BALANCE QUESTIONS

Reasons for Not Using Alcohol and/or Cannabis

How typical is it for you to not drink alcohol on a day like yesterday? (0=Not at all typical – 6=Very typical)

Did you see anyone drinking alcohol yesterday?

- Yes
- No

Do you think any of your friends drank alcohol yesterday?

- Yes
- No

How typical is it for you to not use marijuana on a day like yesterday? (0=Not at all typical – 6=Very typical)

Did you see anyone using marijuana yesterday?

- Yes
- No

Do you think any of your friends used marijuana yesterday?

- Yes
- No

Below are reasons why people do not drink. Thinking back to yesterday, select the reason(s) that best explain why you did not drink yesterday:

	True	False
1. I only drink on special occasions.		
2. I only drink on certain days of the week (e.g., on the weekend).		
3. I did not feel well physically from drinking earlier in this week.		
4. I did not feel well physically for other reasons.		
5. Experienced negative consequences the last time I drank.		
6. I had to work at my job.		
7. I had too much school work to do.		
8. I had nobody to drink with.		
9. I couldn't obtain alcohol.		
10. I had no desire to drink.		
11. I usually don't drink on this night of the week.		

Below are reasons why people do not use marijuana. Thinking back to yesterday, select the response by checking yes or no that best explain why you did not use marijuana yesterday:

	Yes	No
1. No desire to use marijuana		
2. Could not obtain marijuana		
3. Nobody to use marijuana with		
4. Had to work at job		
5. Too much school work		
6. Usually don't use marijuana on this night		
7. Experienced negative consequences the last time I used marijuana.		

Media Use

The next several questions are about other activities you may have done yesterday.

Yesterday, did you watch television?

- Yes
- No

[If yes to above] Approximately how long did you spend watching television **yesterday**?

- Less than 1 hour
- 1 to <2 hours
- 2 to <3 hours
- 3 to <4 hours
- 4 to <5 hours
- 5 to <6 hours
- 6 or more hours

[If yes to above] Which type(s) of program(s) did you watch yesterday? *Select all that apply*

[ ] action
[ ] animation
[ ] comedy
[ ] drama
[ ] reality TV
[ ] recreation/sports
[ ] sitcom
[ ] soap operas
[ ] talk show
[ ] other (please describe): _____

[If no to above] How typical is it for you to not watch television on a day like **yesterday**? (0=not at all typical to 6=very typical)

[If no to above] Do you think you will watch television **today**?

- Yes
- No

Yesterday, did you use the internet?

- Yes
- No

[If yes to above]Approximately how long did you spend using the internet **yesterday**?

- Less than 1 hour
- 1 to <2 hours
- 2 to <3 hours
- 3 to <4 hours
- 4 to <5 hours
- 5 to <6 hours
- 6 or more hours

[If yes to above]What was the purpose(s) of using the internet **yesterday**? (check all that apply)

[ ] check email
[ ] use social network
[ ] view videos or pictures
[ ] shopping
[ ] reading gossip site
[ ] read or post blog
[ ] play internet game
[ ] search for information
[ ] other (please describe): _____

[If no to above] How typical is it for you to use the internet on a day like **yesterday**? (0=not at all typical – 6=very typical)

[If no to above] Do you think you will use the internet **today**?

- Yes
- No

Yesterday, did you visit or post on a social media site?

- Yes
- No

[If yes to above] Which social media site(s) did you use? (select all that apply)

[ ] Facebook
[ ] Pinterest
[ ] Instagram
[ ] LinkedIn
[ ] Twitter
[ ] Other (please describe): _____

[If yes to above] Approximately how long did you spend reading or posting on social media sites **yesterday**?

- Less than 1 hour
- 1 to <2 hours
- 2 to <3 hours
- 3 to <4 hours

- 4 to <5 hours
- 5 to <6 hours
- 6 or more hours

[If no to above] How typical is it for you to not use social media on a day like yesterday? (0=not at all typical – 6 = very typical)

[If no to above] Do you think you will use a social media site **today**?

- Yes
- No

Time Management

Yesterday did you:

	Yes	No
Make a list of the things you had to do?		
Plan your day before you started it?		
Make a schedule of activities for the day?		
Spend time planning?		
Set and honor priorities?		
Find yourself doing things that interfered with your current task simply because you hat to say "no" to people?		
Feel as though you were in charge of your own time?		
Think about ways you could improve the way you manage your time?		
Make constructive use of your time?		

About the Study

1. Where were you when you took the survey today?
   - Work or school
   - Home
   - Other person's home
   - Other (Please describe): _____
2. What type of device did you use to take the survey today?
   - Smartphone
   - Tablet
   - Laptop computer

- Desktop computer
- Other (Please describe): _____

APPENDIX W

DEMOGRAPHICS

1. What is your age?
2. What is your student status?
    - Full-time
    - Part-time
3. What is your class standing?
    - Freshman
    - Sophomore
    - Junior
    - Senior
    - Graduate
    - Other (Please describe): _____
4. Do you have reliable access to a computer, tablet, or smartphone that is connected to the internet (at least daily)?
    - Yes
    - No
5. Current residence:
    - On-campus dormitory/residence hall
    - On-campus living-learning community
    - On-campus themed community
    - Off-campus house or apartment
    - Greek affiliated residence (fraternity/sorority)
    - With family
    - Other (Please describe): _____
6. What is your GPA? (fill in)
7. What is your involvement with social fraternities or sororities?
    - A current member
    - Currently pledging
    - Not a member, but regularly or occasionally attend Greek social events
    - Not a member, and do not attend Greek events
8. Are you Hispanic or Latinx?
    - Yes
    - No
9. Which racial group best describes you? (select all that apply):
    - African-American/Black
    - Asian
    - Native Hawaiian or other Pacific Islander
    - Caucasian or White
    - Native American

- Other (Please describe): _____

10. Are you an athlete on an ODU NCAA or club team?
    - Yes
    - No
11. What is your gender?
    - Cisgender man (your gender identity corresponds to your sex assigned at birth)
    - Cisgender woman (your gender identity corresponds to your sex assigned at birth)
    - Transgender Man
    - Transgender Woman
    - Nonbinary
    - Other (Please describe): _____
12. What is your marital status?
    - Single
    - In a committed relationship
    - Married
    - Divorced
    - Other (Please describe): _____
13. How do you define your sexual identity/orientation?
    - Only homosexual
    - Mostly homosexual
    - Bisexual
    - Mostly heterosexual
    - Only heterosexual
    - Other (Please describe): _____
14. Have you ever received formal treatment for your alcohol use?
    - Yes
    - No

[If yes] Please indicate the type of treatment you received. *Check all that apply*

[ ] Minister, priest, rabbi, chaplain, or other religious leader
[ ] Psychologist, social worker, psychiatrist, substance abuse or other counselor
[ ] Personal physician
[ ] 12 step program or other support group
[ ] Outpatient alcohol treatment program
[ ] Residential alcohol treatment program (such as inpatient rehab or detox)
[ ] Other (Please describe):

15. What is your weight in pounds? (only enter the number): _____
16. What is your height in feet and inches? (drop down menu for both)

APPENDIX X

CONTACT AND COMPENSATION INFORMATION

The following information will only be seen by the researchers and will be separated from your answers at the conclusion of the study. However, it is necessary to compensate you for your participation, and to send you the daily surveys (which is the main part of this study):

1. What is your first name? _____
2. What is your last name? _____
3. Which time zone do you/will you live in for the majority of the study?
   - Hawaii
   - Alaska
   - PST
   - MST
   - CST
   - EST

3. What is your ODU email address (including "@odu.edu")? _____
4. Please repeat your ODU email address. _____
5. As part of this study, you may receive reminders to complete the daily surveys. It would contain text only. Would you prefer to receive these reminders via email or text message?
   - Email
   - Text message

[If text message] Please provide your mobile phone number: _____

[If text message] Knowing someone's cell phone carrier allows us to type up an email, but send it as a text message. If you signed up to receive text message reminders, who is your phone service carrier?

   - Verizon
   - AT&T
   - T-Mobile
   - Spring
   - Boost
   - Other (Please describe): _____

6. To receive Sona credit, please enter your Sona ID in the space below. Note: Please allow up to two weeks for your Sona credit to appear. _____
7. Please re-enter your Sona ID in the space below. _____
8. If you complete at least 85% of the daily surveys (18 or more), you can be entered into a raffle to win one of 4 $25 Amazon e-giftcards. If you would like to be entered, please provide the email address to which you would like the Amazon e-giftcard to be sent. _____
9. Please re-enter your email address: _____

After Survey

Thank you for your participation! Click on the video for more information regarding the daily surveys.

If you have any questions regarding this survey or future surveys, feel free to contact the researchers. The researchers should be able to answer them via email:
Jennifer Shipley: jship002@odu.edu
Dr. Abby Braitman: abraitma@odu.edu
If at any time you felt pressured to participate, or if you have any questions about your rights or this form, then you should call Dr. Tancy Vandecar-Burdin, the current IRB chair, at 757-683-3802, or the Old Dominion University Office of Research, at 757-683-3460.
If you believe you or someone you know may need help with either substance use or psychological concerns, the Substance Abuse and Mental Health Services Administration (SAMHSA) runs a 24-hour mental health hotline that provides education, support, and connections to treatment at the number 1(800) 662-4357.
You can also contact the ODU Office of Counseling Services, located inside Webb Center (1526): https://www.odu.edu/counselingservices
Call 757-683-4401 (or extension 34401 on campus) to schedule an appointment.

APPENDIX Y

ATTENTION CHECKS IN BASELINE SURVEY

[After Cannabis DDQ] Which is the largest number?
a. 75
b. 53
c. 89
d. 30
[Within Comprehensive Marijuana Motives Questionnaire (Lee et al., 2009)] Select 3 = Half of the time for this item
[Within Protective Behavioral Strategies for Alcohol Questionnaire (Sugarman & Carey, 2007)] Select 3 for this item
[Within Perceived Importance of Marijuana to the College Experience Scale (Pearson et al., 2017)] Select 5 = Strongly Agree for this item

VITA

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Education

2022	**M.S.** Psychology, Old Dominion University; Norfolk, VA Thesis Title: *Simultaneous Alcohol and Cannabis Use in College Students: Examining Context, Route of Administration, Cognitive Factors, and Consequences via Daily Diary* Committee Chair: Abby L. Braitman, Ph.D.
2016	**M.P.H.** Health Behavior-Health Promotion, The University of Arizona; Tucson, AZ Internship report title: *Comparison of Physical Activity Measures among Ovarian Cancer Survivors* Committee: Cynthia A. Thomson, Ph.D., RD, David O. Garcia, Ph.D., FACSM, and Jennifer W. Bea, Ph.D.
2014	**B.S.** Exercise Science, California Lutheran University; Thousand Oaks, CA Capstone title: *The Effect of Video Images on Motivation during Exercise* Presented to: Louise A. Kelly, Ph.D., and Hugh Lamont, Ph.D.