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A Re-Examination of the Motivations for Using Substances Questionnaire: Motives for Alcohol and Simultaneous Alcohol and Marijuana Use

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A RE-EXAMINATION OF THE MOTIVATIONS FOR USING SUBSTANCES QUESTIONNAIRE: MOTIVES FOR ALCOHOL AND SIMULTANEOUS ALCOHOL AND MARIJUANA USE

by

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ABSTRACT

The growing body of research examining simultaneous alcohol and marijuana (SAM) use suggests motivations for alcohol-only, marijuana-only, and SAM use, especially among college-aged people, warrant further examination to ultimately tailor interventions to not only specific substances but also the underlying motivations for using those substances. Thus, the purpose of the present study was to test the measurement invariance of a novel broadband motives measure, the Motivations for Using Substances Questionnaire (MUSQ), across alcohol-only, marijuana-only, and SAM users and further test motivations' relationships to use-related problems. However, due to insufficient sample sizes of marijuana-only users (n = 175), the MUSQ was subjected to two-group invariance testing across alcohol-only (n = 461) and SAM users (n = 374).

Confirmatory factor analysis of the MUSQ revealed an 8-factor baseline model that combined items developed from the MUSQ's piloting study related to (a) reducing anxiety and unpleasant arousal, reducing negative affect, and increasing positive affect under one latent variable (Manage Emotional States; MES) and (b) using to manage negative social interactions with conformity motives under one latent variable (Manage Negative Social Interactions – Revised; MNSI-r). Configural and metric invariance were observed and partial invariance at the scalar level was demonstrated for the MUSQ across groups. SAM users tended to use more frequently for all motives except MNSI-r than alcohol-only users. MES motives consistently predicted use-related problems across groups. Thus, the MUSQ is a psychometrically appropriate assessment tool to evaluate meaningful differences in the reasons individuals use alcohol by itself and in combination with marijuana.

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CHAPTER I – INTRODUCTION

Findings from the most recent National Survey on Drug Use and Health suggest young adults aged 18 to 25 demonstrated the highest prevalence for both past month alcohol use (55.1 percent) and past year marijuana use (34.8 percent). Of greater concern, this age group represents the highest prevalence of alcohol use disorders (10.1 percent) and cannabis use disorders (5.9 percent) compared to those aged 12 to 17 and 26 and older (Substance Abuse and Mental Health Services Administration, 2019). Indeed, the overwhelming majority of full- and part-time college students at public 4-year institutions fall within this age range (McFarland et al., 2018) and make up a notable proportion of those individuals who may experience a plethora of negative consequences from alcohol, marijuana, or combined use.

College students appear to be a somewhat unique group when it comes to problematic use of alcohol and marijuana. For example, compared to non-college peers, college students are more likely to drive under the influence of alcohol and engage in binge drinking. Alcohol use in college is also associated with greater likelihood of victimization of others, including assaulting others sexually and physically, as well increased risk of killing others by driving under the influence (Hingson, Zha, & Weitzman, 2009). Regarding past month marijuana use, of the college students who report negative consequences, the most frequently endorsed consequences include driving under the influence, saying or doing things that are embarrassing, feeling groggy or tired the next morning, and using when they did not intend to use (Pearson, Liese, & Dvorak, 2017).

Of those who use alcohol, more young adults use both alcohol and marijuana simultaneously, (i.e., co-ingestion; 15.3 percent) as opposed to only using each within a given time period (e.g., using both within the past month, referred to in the existing literature as "concurrent use"; 7.7 percent; Subbaraman & Kerr, 2015). Simultaneous versus concurrent use and alcohol-only use uniquely predicts negative consequences from use, use frequency, and use quantity (Linden-Carmichael, Stamates, & Lau-Barraco, 2019). Moreover, simultaneous use predicts a two- to three-fold greater likelihood of driving under the influence, social problems, and impairment in major life domains (e.g., health, finances, occupation, academic, and other social roles) compared to alcohol-only use, as well as a greater likelihood of driving under the influence compared to concurrent use (Subbaraman & Kerr, 2015). Simultaneous users also report greater acute synergistic effects (e.g., feeling more intoxicated, difficulty concentrating, and clumsiness) and exhibit greater odds for engaging in unprotected sex compared to marijuana- or alcohol-only users (Lee, Cadigan, & Patrick, 2017; Metrik, Caswell, Magill, Monti, & Kahler, 2016). In addition, college students who use moderate quantities of both alcohol and marijuana have reliably lower grade point averages (GPAs) than those who use alcohol only, minimal quantities of both alcohol and marijuana, and those who use neither. However, GPA differences between moderate concurrent and simultaneous use have yet to be observed (Meda et al., 2017). Past month combined marijuana and alcohol use (undifferentiated between concurrent and simultaneous use and controlled for binge drinking) by college students has also been associated with a higher frequency of missing classes, becoming nauseous or vomiting, and other actions later regretted compared to alcohol-only users (Shillington & Clapp, 2001).

The growing body of research investigating simultaneous alcohol and marijuana use (SAM) suggests that the motivations for alcohol-only, marijuana-only, and SAM use among college students warrant further examination, with the ultimate goal of tailoring interventions to not only specific substances but also to the underlying motivations for using those substances. Thus, the purpose of this study is to test the measurement invariance of a relatively novel broadband motives measure (i.e., Motivations for Using Substances Questionnaire) across student alcohol-only, marijuana-only, and SAM users and further test motivations' relationships to use-related problems. In the next section, the existing literature on measurements of motives for alcohol use, marijuana use, and SAM use will be reviewed, highlighting the need to further examine these differences in a college sample using a greater breadth of motivations.

Alcohol Use Motives

Although several measures of alcohol use motives can be identified dating back to at least the 1960s (e.g., Definitions of Alcohol Scale; Mulford & Miller, 1960), we will focus on those measures still circulating in the literature. The Drinking Motives Questionnaire (DMQ) initially yielded a three-factor model of motives for alcohol use in a representative adult sample: (1) Coping, (2) Affective Enhancement, and (3) Social Rewards (Cooper, Russell, Skinner, & Windle, 1992) that was later replicated with college students (Stewart, Zeitlin, & Samoluk, 1995). A fourth factor emerged (i.e., Conformity) through the addition of items to the DMQ – Revised (DMQ-R) that targeted adolescent alcohol use (Cooper, 1994), and the four-factor model also appeared to fit the data better compared to alternative models within college samples (MacLean & Lecci, 2000; Martens, Rocha, Martin, & Serrao, 2008). Finally, the Modified DMQ-R yielded a

five-factor model that, with the addition and modification of several items, separated Coping into Coping-Anxiety and Coping-Depression factors within a college sample (Grant, Stewart, O'Connor, Blackwell, & Conrod, 2007). Other less frequently utilized measures of alcohol use motives have yielded comparable motive factors to all versions of the DMQ (e.g., Carpenter & Hasin, 1998; Cronin, 1997).

Marijuana Use Motives

Heavily influenced by the DMQ-R, the Marijuana Motives Measure (MMM) was developed to index motivations to use marijuana. The MMM was created by exchanging the DMQ-R's "drink" with "use marijuana" and included several items for a fifth Expansion (of the mind) scale. Ultimately, the inclusion of an Expansion motive scale for college student marijuana users predicted unique variance in frequency of use that was not present in alcohol users' responses to this scale (Simons, Correia, Carey, & Borsari, 1998). In addition, college students used marijuana for Expansion motives at a greater frequency than alcohol users and alcohol was used more often for Social Reasons, while the frequency at which alcohol and marijuana use occurred for Coping, Conformity, and Enhancement reasons were similar (Simons, Correia, & Carey, 2000). Thus, there appears to be commonality between alcohol motives and marijuana motives themselves (i.e., Coping, Conformity, Social Reasons, Enhancement) and the frequency at which use of these substances occur for Coping, Conformity, and Enhancement reasons, while the Expansion motives differentiate marijuana use, indicating a unique target for intervention.

The Comprehensive Marijuana Motives Questionnaire (CMMQ) was developed initially with a qualitative approach to identify common themes for marijuana motives

among college students (Lee, Neighbors, & Woods, 2007; Lee, Neighbors, Hendershot, & Grossbard, 2009). In the pilot study, incoming college freshman self-identified their top five reasons for using marijuana and researchers coded the motives into 19 distinct motive constructs: (1) Enjoyment/Fun, (2) Conformity, (3) Experimentation, (4) Social Enhancement, (5) Boredom, (6) Relaxation, (7) Coping, (8) Availability, (9) Relative Low Risk, (10) Altered Perception or Perspectives, (11) Activity Enhancement, (12) Rebellion, (13) Alcohol Intoxication, (14) Food Enhancement, (15) Anxiety Reduction, (16) Image Enhancement, (17) Celebration, (18) Medical Use, and (19) Habit (Lee, Neighbors, & Woods, 2007). Through a factor analysis, the CMMQ ultimately yielded twelve factors: (1) Enjoyment, (2) Conformity, (3) Coping, (4) Experimentation, (5) Boredom, (6) Alcohol, (7) Celebration, (8) Altered Perceptions, (9) Social anxiety, (10) Relative Low risk, (11) Sleep/Rest, and (12) Availability. Extending the breadth of motives with the CMMQ, we can see parallel motives to the MMQ (i.e., Enjoyment with Enhancement, Conformity with Conformity, Coping and Social Anxiety with Coping, Celebration with Social Reasons, Altered Perceptions and Experimentation with Expansion) as well as other relevant reasons for marijuana use introduced into a motive measure that uniquely predicted greater frequency of use (i.e., Altered Perceptions, Relative Low Risk, Sleep/Rest, Enjoyment, Boredom) and use-related problems (i.e., Coping, Sleep/Rest; Lee, Neighbors, Hendershot, & Grossbard, 2009).

Although an Alcohol scale emerged in the CMMQ, the item content was more related to reduced inhibitions from alcohol leading to marijuana use (e.g., “because you were drunk”) as opposed to motives associated with enhancing or otherwise managing the effects of these or other substances. Relative Low Risk and Availability factors were

also novel to the measurement of marijuana motives, wherein Relative Low Risk was positively related to frequency of use and Availability, although not a significant predictor of frequency of use or use-related consequences, emerged as a salient factor, suggesting it may nevertheless be an important construct in understanding where to target interventions. Finally, although Rebellion did not emerge in the final factor structure, we see that it did emerge in a broadband measure of substance use motives that will be described later (i.e., Altenberger, 2020).

SAM Use Motives

In a pioneering study of SAM use motives, Patrick, Fairlie, and Lee (2018) developed a questionnaire that yielded four factors: (1) Conformity, (2) Positive Effects, (3) Calm/Coping, and (4) Social. The Conformity factor mirrored content from the previously mentioned Conformity content, Social included content from both Social Reasons and Celebration, and Calm/Coping parallel content from Social Anxiety and Sleep/Rest. Participants in this study completed the DMQ-R, CMMQ, and the new SAM motive measure. Results from these responses suggested participants most frequently used alcohol-only for Enhancement and Social Reasons motives, marijuana-only for Enjoyment, Availability, and Altered Perceptions motives, and SAM for Positive Effects and Social motives. Similar to patterns with DMQ-R alcohol use responses, Conformity motives for SAM use were associated with a lower rate of SAM use frequency. SAM Social motives and alcohol Coping and Enhancement motives were associated with a higher rate of respective substance use frequency. The DMQ-R's Social, Coping, and Enhancement motives were also positively associated with alcohol use-related problems. Higher endorsement of the CMMQ's Alcohol motives and lower endorsement of

Experimentation motives predicted a greater likelihood of SAM use, while higher endorsement of the SAM use Calm/Coping and lower endorsement of Conformity motives predicted a greater likelihood of SAM use. The CMMQ's Availability motives were associated with a lower rate of marijuana-only use frequency, while Boredom and Sleep/Rest motives were associated with a higher rate of marijuana-only use frequency. The SAM use Calm/Coping and Social motives were associated with a higher rate of marijuana use. The SAM use Conformity motives, again, predicted a lower rate of marijuana-only use. Finally, the CMMQ's Conformity and Boredom motives, as well as the SAM use Calm/Coping motives, were positively associated with marijuana use-related problems.

There are two noteworthy observations from the SAM use motive measure development: (a) depressive and escape from negative affect states motives were not included in the preliminary or final item content for this SAM use motive measure and (b) Positive Effects appears to include content that had yet to be considered for SAM use, in alcohol motive measures, or marijuana motive measures (i.e., essentially managing and influencing the effects of other substances; e.g., "to increase the positive effects I get from alcohol" or "cross-faded effects are better") but has been included in other measures of substance use motives. Thus, likely-relevant alcohol, marijuana, and SAM use motives captured in other substance-specific or broadband substance motive measures will be described below.

Other Relevant Alcohol and Marijuana Motives

Blevins, Lash, and Abrantes (2017) developed the Clinical Substance Use Motives Questionnaire (CSUMQ) to examine reasons for individual's typical substance

of use among alcohol, opiates, and "cocaine and other stimulants" in a residential treatment sample. A factor analysis of the items suggested an eight-factor model: (1) Social/Enhancement, (2) Other Substance Use, (3) Coping with Anxiety, (4) Withdrawal, (5) Loneliness, (6) Pain/Sleep, (7) Coping with Depression, and (8) Relieving Boredom/Getting Energy. Although marijuana and SAM motives were not examined in this study, there are a few important findings to highlight. First, large correlations were found between alcohol use and both Coping with Anxiety and Coping with Depression motives, further suggesting both facets of coping are salient and warrant consideration. Second, Withdrawal content (e.g., "To avoid withdrawal symptoms") and Other Substance Use motives (e.g., "To counteract the effects of other substances"), although parsed into separate factors in this measure, appear to capture the aforementioned theme of managing the effects of substances that had yet to be captured in an alcohol, marijuana, or SAM use motive measure. In a study of alcohol, marijuana, amphetamine, ecstasy, LSD, and cocaine use among young adults (aged 16 to 22 years), marijuana (44.3 percent) and alcohol (41 percent) were the most frequently used to not only manage the effects of other substances but also to be used in combination with other substances for this reason (marijuana = 64.6%; alcohol = 35.9 percent; Boys, Marsden, & Strang, 2001). Individually, alcohol and marijuana use among 18-year-old high school seniors to increase the effects of other substances has been associated with greater frequency of use among each substance, respectively (Patrick, Schulenberg, O'Malley, Johnston, & Bachman, 2011).

To date, substitution motives (e.g., using one substance in place of another or to supplement a substance when it is not available) have been considered in the synthetic

cannabinoid use (Loeffler, Delaney, & Hann, 2016), kratom use (Smith & Lawson, 2017), and misuse of opioid substitution treatment motive literature (e.g., buprenorphine, naloxone, methadone; Schmidt et al., 2013). On the surface, motives related to substituting one substance for another appear to be at least minorly related to managing the effects of other substances. Individuals who substitute one substance for another, however, appear to do so to reduce or completely stop use of another substance that may be problematic legally, occupationally, relationally, or physiologically, to avoid detection from external sources (e.g., through urine screens), to counteract the effects of tolerance to another substance, or because they have limited access to the substance of choice. Alcohol and marijuana may very well each be used in substitution of another substance for these reasons. With the exception of marijuana being used to avoid detection on a drug screen, it may still be used to avoid detection otherwise by co-workers, family members, and peers, especially if ingested with edibles versus smoking. Further, alcohol may be used to substitute marijuana at or after age 21 years, given the shift to perhaps greater availability and statutory legality (Crost & Guerror, 2012).

The Motivations for Using Substances Questionnaire (MUSQ)

The MUSQ was recently developed to capture a broader range of motivations, broader range of substances addressed, and more nuanced facets of motivational constructs that had yet to be captured within a single substance use motive measure (Altenberger, 2020). In the pilot study of the MUSQ, participants were asked to respond to 112 motivation items based on past motive measures, existing motives in the literature, and researcher-developed motive items for a variety of substances, including alcohol, marijuana, opioids, stimulants, sedatives/anxiolytics, and hallucinogens/dissociatives

(See Appendix H in Altenberger, 2020 for the initial item set). The MUSQ motive items were assessed with three separate prompts in an attempt to capture salient constituents of motivations to use, guided by the Incentive Sensitization Theory's differentiation of "wanting" and "liking" in relation to hedonistic non-pathological substance use and substance addiction through explicit measurement, that had thus far not been considered in the motive measure literature (Robinson & Berridge, 1993; Goldstein et al., 2010; Evans et al., 2006). First, participants rated their overall degree of Wanting, or craving, substances by responding to the questions, "When you think about alcohol and/or drugs, how intense are your cravings?" and "When you encounter a reminder about alcohol and/or drugs (e.g., people, places, things), how intense are your cravings?" on a 6-point Likert-type scale ranging from "Not at all" to "Extreme." Consistent with other motive measures, participants first responded to the motive items by indicating how frequently they use alcohol and/or drugs for that reason or motive (1 = Never, 6 = Always; Frequency). New to the measurement of motivations to use substances, the MUSQ also assessed participants' degree of liking and satisfaction for each item, represented by asking participants to rate how much they like using alcohol and/or drugs for that reason or motive (i.e., degree of subjective pleasure from using a substance to achieve that goal; 1 = Not at all, 6 = Extremely; Liking) and how much that reason or motive is satisfied (i.e., fulfilled) when they use alcohol and/or drugs (1 = Not at all, 6 = Extremely; Satisfaction).

Factor Structure of the MUSQ

Although sample sizes for Liking and Satisfaction responses were too small for factor analyses, an exploratory factor analysis and item analysis of motive Frequency

items yielded an 84-item, 12-factor model that fit the data better than 8-, 9-, 10-, 11-, 13-, and 14-factor models: (1) Reduce Anxiety/Unpleasant Arousal, (2) Conformity, (3) Effects of Other Substances, (4) Relative Low Risk, (5) Positive Social Interactions, (6) Rebellion, (7) Altered Perceptions/Experiential Processes, (8) Performance/Arousal Enhancement, (9) Increase Positive Affect, (10) Manage Negative Social Interactions, (11) Reduce Negative Affect, and (12) Substitution. Ultimately, the 12-factor model captured 67.99 percent of the variance in motivations for substance use, and the factor-based subscale scores demonstrated excellent internal consistencies evaluated with coefficient alphas and moderate to strong inter-item correlations.

Limitations and Strengths of the MUSQ

Due to low sample sizes in regression models of Frequency, Liking, and Satisfaction predicting frequency of substance use and use-related problems, solid conclusions could not be drawn from these analyses in the pilot study of the MUSQ's psychometric properties. Further, in an attempt to develop a broadband measure of substance use motives across substances by asking participants to respond based on their overall use of "alcohol and/or drugs," results may have been skewed toward alcohol, marijuana, and stimulant motives, while still muddied by other substance motives, with the overwhelming majority of participants identifying alcohol (81.7 percent) and cannabis (61 percent) in their top three drugs of choice, followed substantially less by prescription stimulants (17.2 to percent), as all other substances in participants' top three drugs of choice presented at much lower frequencies (i.e., .3 percent [synthetic cathinones] to 12.8 percent [prescription opioids]). Given the imbalanced distribution of substances addressed in this study, a Performance/Arousal Enhancement factor likely

would not have emerged otherwise. The Manage Negative Social Interactions factor yielded only two strong-loading items, and, upon further reflection, it was noted that one item (i.e., to avoid or manage conflict with others) was double-barreled and could further be parsed apart to potentially yield a three-item factor with stronger psychometric properties. Theoretically, these items could also fit with Conformity content or load negatively with Positive Social Interactions content with the separation and addition of a third item. Finally, participants responded to motive items based both on past and current use of substances, which likely further muddied any conclusions that could be drawn.

With these limitations in mind, the MUSQ demonstrated several strengths in adding to the motive measure literature, and the pilot study allowed for clearer future directions with the MUSQ that will likely add to its utility in the present study. The MUSQ captured common motives to use that we have seen in previous motive measures, such as Conformity, Reduce Anxiety/Unpleasant Arousal and Reduce Negative Affect (Coping), Increase Positive Affect (Enhancement), Altered Perceptions/Experiential Processes (Expansion), and Positive Social Interactions (Social). Comparable to the Modified DMQ-R and CSUMQ, the MUSQ separated coping with negative affect into coping with anxiety (Reduce Anxiety/Unpleasant Arousal) and coping with other various negative affective states (Reduce Negative Affect). Other rarely considered motives also emerged in the MUSQ that warrant consideration and further inspection. First, Rebellion emerged as a salient factor from the MUSQ pilot data, which not only has been seldom considered in substance use motives but also did not emerge in the final factor structure of the CMMQ, suggesting these motives may be more relevant for other substances, such as alcohol or SAM use. Second and unique to the MUSQ, social interaction motives

separated into two distinct factors that measured using to mitigate negative social interactions (Manage Negative Social Interactions) and using to experience positive social interactions (Positive Social Interactions). Finally, to the author's knowledge, Effects of Other Substances, Relative Low Risk, Altered Perceptions/Experiential Processes, and Substitution content emerged from a factor analysis for the first time in a single comprehensive substance use motive measure – content that would arguably be important in assessing alcohol-only, marijuana-only, and SAM use beyond what assessment tools are available to date.

The Present Study

Given the limitations and strengths of the initial study of the MUSQ, as well as the growing concern for further understanding characteristics of SAM use and how they compare to alcohol- and marijuana-only use, there were four major aims of this study. The present psychometric study proposed to further examine motivations to use across these three groups of users to determine whether and where they differ through evaluation of the measurement invariance of the MUSQ. By using the most comprehensive questionnaire assessing motivations to use at this time, the MUSQ was expected to capture more nuanced and critical information on individuals' reasons for using alcohol, marijuana, and both simultaneously, adding to the construct validity by examining how these patterns relate to frequency of use and use-related problems. Finally, this study addressed limitations and build on the results of the pilot MUSQ study by soliciting responses based on current (i.e., past month) substance use and specifying which substances (or combination of substances) were to be referenced in completing the measure to provide more clarity in the relationships between motives and substances.

Further, limitations of the two-item factor, Manage Negative Social Interactions, were addressed by separating a double-barreled item and determining whether this factor held as a separate factor or fit better with an alternative factor (i.e., Conformity or negatively with Positive Social Interactions). This adjustment would ideally allow for the recommended minimum of three indicators per factor to test invariance should the factor hold (Byrne, Shavelson, & Muthen, 1989; MacCallum, 1995).

Hypotheses

Hypothesis 1: Frequency of Use Predicting Use-Related Problems

1. Frequency of alcohol- and marijuana-only use would positively predict alcohol-related and marijuana-related problems, respectively.
2. Frequency of SAM use would predict greater alcohol-related and marijuana-related problems than frequency of alcohol- and marijuana-only use.

Hypothesis 2: Confirmatory Factor Analysis (CFA) Models

1. With the potential exception of Managing Negative Social Interactions content, it was expected that the original MUSQ factor model would fit the data for alcohol-only, marijuana-only, and SAM users' responses.
2. In testing the baseline model fit for Managing Negative Social Interactions content by separating a double-barreled item into two items, it was hypothesized that this would allow for stronger psychometric properties of this factor (i.e., coefficient alphas) and allow the items to continue loading together in this latent variable.
3. Alternatively, these items could fit models better under the Conformity latent variable or negatively with the Positive Social Interactions latent variable.

Hypothesis 3: Internal Consistency of the MUSQ Scales

Consistent with the psychometric properties of the MUSQ in the pilot study, it was hypothesized that good internal consistency reliability of the factor-derived subscales would be observed from the baseline CFA models.

Hypothesis 4: Measurement Invariance of the MUSQ Across Substance Groups

It was hypothesized that the MUSQ would demonstrate configural invariance (same number of factors), metric invariance (equivalent factor loadings), and scalar invariance (equivalent item intercepts) across the three groups. While full scalar variance is difficult to achieve, it was expected that this level of invariance would at least be met at a partial invariance level.

Hypothesis 5: Mean Differences in MUSQ Latent Factors

It was hypothesized that there would be differing degrees of salience of motives across each substance group. The following were predictions for latent means:

1. Several common underlying motive means would not significantly differ across all three substance groups: (1) Reduce Anxiety/Unpleasant Arousal, (2) Conformity, (3) Effects of Other Substances, (4) Positive Social Interactions, (5) Increase Positive Affect, and (6) Reduce Negative Affect.
2. Two motives, Relative Low Risk and Rebellion, would not demonstrate significantly different means for alcohol- and marijuana-only use comparisons, but alcohol- and marijuana-only users would demonstrate significantly higher means for Relative Low Risk and Rebellion than SAM users.
3. Marijuana-only users would demonstrate significantly higher means for Altered Perceptions/Experiential Processes compared to alcohol-only and SAM users.

4. Given the novel and rare examination of Substitution and Manage Negative Social Interactions content, group mean difference testing would be exploratory.

Hypothesis 6: MUSQ Motives Predicting Use-Related Problems

Irrespective of which substance group was referenced in MUSQ responses:

1. Several motives would predict more problems: (1) Reduce Anxiety/Unpleasant Arousal, (2) Positive Social Interactions, (3) Increase Positive Affect, and (4) Reduce Negative Affect.
2. Conformity would negatively predict problems.
3. Altered Perceptions/Experiential Processes would either negatively predict or not contribute to the prediction of use-related problems.
4. Evaluation of the salience and directionality of all other motives in this model (i.e., Rebellion, Substitution, Relative Low Risk, Manage Negative Social Interactions, and Effects of Other Substances) would be exploratory.

CHAPTER II – METHODOLOGY

IRB Statement

Collection of data was initiated after approval by The University of Southern Mississippi's Institutional Review Board (see Appendix for IRB approval letter).

Participants

Participants were recruited from an undergraduate psychology research pool at a medium-sized Southeastern United States university. Participants were also recruited from social media outlets (e.g., Facebook, Reddit). Individuals 18 years of age or older who had used marijuana or alcohol in the past 30 days were invited to participate. Ideally, we aimed to recruit 675 participants (225 alcohol-only, 225 marijuana-only, and 225 SAM users) based on Kelloway (2014) and Anderson and Gerbing's (1984) recommendations for sample sizes > 200 for models that make use of three indicators per latent variable; however, the literature suggests marijuana-only users are a relatively smaller population (e.g., Meda et al., 2017).

Skalisky, Wielgus, Aldrich, & Mezulis, 2018) and prevalence rates for simultaneous use are approximately twice the rate of concurrent use (Subbaraman & Kerr, 2015). Therefore, although we expected our sample to be limited in power to examine marijuana-only users, we aimed to address this limitation by soliciting marijuana-only motive responses from both those who used marijuana only and those who reported concurrent, but not simultaneous, alcohol and marijuana use.

Materials

Frequency of Substance Use

First, participants indicated their current alcohol and marijuana use statuses (i.e., "Have you used alcohol in the past 30 days?"; "Have you used marijuana in the past 30 days?"). For those who indicated they had recently used both, participants were asked to indicate whether alcohol and marijuana were used simultaneously (i.e., "In the past 30 days, have you used alcohol and marijuana simultaneously [i.e., co-ingested them in the same sitting or used within a time frame that allowed you to feel the effects of both]?"). Dichotomous yes/no responses were coded (i.e., 1 = Yes, 2 = No).

For each substance use status group (alcohol-only, marijuana-only, and SAM users), we assessed frequency of use with the question, "On how many occasions have you [only used alcohol; only used marijuana; used alcohol and marijuana simultaneously (i.e., co-ingested them in the same sitting or used within a time frame that allowed you to feel the effects of both)] in the past 30 days?" (1 = Once, 2 = Twice, 3 = 3-5 occasions, 4 = 6-9 occasions, 5 = 10-15 occasions, 6 = 16 to 20 occasions, 7 = 21-31 occasions, 8 = 32 or more occasions). We also assessed frequency of binge drinking with the question, "On how many occasions have you had five [men] or four [women] more drinks in a row in the past 30 days?" depending on the identified sex of the participant based on the National Institute of Alcohol Abuse and Alcoholism definition of binge drinking (NIAAA, 2004). We utilized the same response scale from the frequency of use question and coded "Never" as 0.

Use-Related Problems

Alcohol use-related problems were assessed with the Rutgers Alcohol Problem Index (RAPI; White & Labouvie, 1989). The RAPI is an 18-item questionnaire that assesses the frequency at which individuals have experienced a broad range of problems that have occurred while drinking or because of drinking in the last year. Responses are rated on a 5-point Likert-type scale (0 = Never, 1 = 1-2 times, 2 = 3-5 times, 3 = 6-10 times, 4 = More than 10 times). Although initially developed for adolescent populations, the RAPI has been validated with adults (Larimer et al., 2001; Marlatt et al., 1998). The RAPI yields a summed total score with no reverse coded items. Marijuana use-related problems were similarly assessed with a parallel version of the RAPI – the Marijuana Problem Index (MPI; Johnson & White, 1989; Knapp, 2017). Both outcome measures have been utilized extensively within the motive measure literature (e.g., Simons, Correia, Carey, & Borsari, 1998; Simons, Gaher, Correia, Hansen, & Christopher, 2005; Lee, Neighbors, & Woods, 2007; Martens, Rocha, Martin, & Serrao, 2008).

Motivations to Use

To assess motivations to use, participants completed the Motivations for Using Substances Questionnaire (MUSQ; Altenberger, 2020). The MUSQ is an 84-item self-report broadband measure that was recently developed to assess individuals' reasons for overall substance use. The MUSQ yielded a 12-factor model: (1) Reduce Anxiety/Unpleasant Arousal (i.e., RAUA; e.g., "To calm down," "To release tension," "To stop worrying"); (2) Conformity (i.e., CNF; e.g., "To avoid feeling rejected," "To not be the only one not doing it"); (3) Effects of Other Substances (i.e., EOS; e.g., "To reduce the effects of, or 'come down' off of another drug," "To enhance the effects of another

drug"); (4) Relative Low Risk (i.e., RLR; e.g., "Because it is more socially acceptable than other drugs," "Because it does not cause me as many problems as other drugs," "Because it is not as bad for you as other drugs"); (5) Positive Social Interactions (i.e., PSI; e.g., "To lose my inhibitions in social situations," "To make social gatherings and parties more fun," "To help me relate to others better"); (6) Rebellion (i.e., REB; e.g., "To experience the thrill of doing something I'm not supposed to do," To rebel against authority or society"); (7) Altered Perceptions/Experiential Processes (i.e., APEP; e.g., "To alter how I perceive my environment [e.g., hear music in greater detail or complexity; enhance or dull sensations; drown out distractions]," "To seek new experiences," "To cause me to perceive things that are not present [i.e., to hallucinate; to see patterns or distortions that are not actually present]"); (8) Performance/Arousal Enhancement (i.e., PAE; e.g., "To focus or pay attention," "To stay awake," "To perform better on school [or occupational] work/tests"); (9) Increase Positive Affect (i.e., IPA; e.g., "To have fun," "To feel more self-confident or effective," "To feel less bored"); (10) Manage Negative Social Interactions (i.e., MNSI; e.g., "To avoid hurting someone's feelings"); (11) Reduce Negative Affect (i.e., RNA; e.g., "To forget, escape, or avoid my memories," "To reduce feelings of hopelessness"); and (12) Substitution (i.e., SUB; e.g., "To use a drug that is more powerful than one I have gotten used to," "To get the same effects as something I'm prescribed when I run out of my prescription"). Cronbach's alphas for the original sample ranged from .85 (MNSI) to .95 (PSI). For the purposes of the current study, we dropped the four items from the PAE subscale as they were primarily included in this broadband measure to capture more functionally stimulating substance use based on content from the Prescription Stimulant Motives Scale (Blevins,

Stephens, & Abrantes, 2016). Further, we separated one MNSI item ("To avoid or manage conflict with others") into two items: "To avoid conflict with others" and "To manage conflict with others."

The MUSQ was initially developed to have participants rate their overall intensity of wanting, or craving, intensity with two items (Wanting) and subsequently respond to each motive item three times – once for frequency of use (Frequency), once for the degree to which participants like that they use substances for that motive (i.e., to achieve that goal; Liking), and once for the degree to which that motive or goal is satisfied via substance use (Satisfaction). While examining all four constructs in relation to alcohol-only, marijuana-only, and SAM use will likely prove beneficial in future examinations of the MUSQ and in further specifying individualized interventions, the current study focused on the measurement structure of ratings of frequency of use for the various motivations. This would build on and expand the existing research on this dimension measured by the MUSQ. As such, only the Frequency portion of the MUSQ was administered. Specifically, Frequency on the MUSQ was measured by asking participants to "Rate the following reasons or motives for your use of alcohol and/or drugs on how frequently you use alcohol and/or drugs for that reason or motive." Responses were recorded on a 6-point Likert-type scale (1 = Never; 2 = Rarely; 3 = Occasionally; 4 = Often; 5 = Almost Always; 6 = Always). To reflect the aim of this study, we replaced "use of alcohol and/or drugs" with "use of alcohol by itself," "use of marijuana by itself" and "use of alcohol and marijuana simultaneously, such that the effects overlap." Scale scores were calculated from the mean of the items that comprise that scale following confirmatory factor analysis and invariance testing.

Design and Procedure

Participants were recruited through a research participant pool in the School of Psychology at a Southeastern university as well as advertisement in appropriate social media outlets. Participants recruited from the Southeastern university registered for the study through an online research participation management system (SONA). Potential participants who indicated a willingness to participate by signing up for the study through SONA subsequently received an email with a web link to complete the online questionnaire generated through Qualtrics, which included the informed consent document and required indication of consent through a check box in order to proceed with the study. Those recruited through social media outlets were prompted to either (a) copy the posted web link into an internet browser or (b) scan the QR code with a smartphone that would open a web browser to the study on the Qualtrics web site.

First, participants were prompted to review an informed consent document detailing the anonymity of responses, voluntary nature of participation, and local mental health services' contact information, for those who may have concerns about their substance use and/or experience any distress from completing the questionnaires. Participants indicated their consent by clicking a checkbox that states "I consent." Participants who clicked the checkbox that states "I do not consent" were exited out of the Qualtrics survey and did not receive credit or have the opportunity to enter into the survey completion drawing. Participants responded to general demographic questions (e.g., age, race/ethnicity, education, gender identity, etc.) and reported their frequency of past 30-day use of alcohol and marijuana. Of those who endorsed recent use of both substances, skip logic led participants to indicate whether they have used SAM within the

past 30 days and, if so, indicate their frequency of recent SAM use. Next, skip logic prompted participants to complete the motive Frequency scales of the Motivations to Use Substances Questionnaire (MUSQ) in reference to the substance classes they endorsed for recent use (i.e., alcohol-only, marijuana-only, concurrent alcohol and marijuana use, or SAM use). Therefore, alcohol-only users completed the MUSQ once based on their reasons for alcohol use; marijuana-only users and those who endorsed recent alcohol and marijuana use, but not SAM use, completed the MUSQ once based on their reasons for marijuana use; and those who endorsed SAM use completed the MUSQ in reference to SAM use. Following completion of the MUSQ, skip logic prompted participants to complete RAPI and MPI measures, as indicated. Following completion of the measures, participants that were not participating for course credit or extra credit were prompted to enter their email to be entered into the drawing for one of four (4) $25.00 Amazon e-gift cards. Participants recruited through SONA received compensation through course credit or extra credit. Measurement invariance was tested using a structural equation modeling (SEM) framework (Rensvold & Cheung, 1998; Steenkamp & Baumgartner, 1998; Vandenberg & Lance, 2000).

Statistical Plan

Data Preparation

Participants' responses were screened for random responding through five validity checks. With these items, participants were asked to select a specific response (e.g., "Please choose the 'never' option"). Participants' responses were considered valid if at least three of the five checks were passed.

MUSQ motive *Frequency* items were assessed for frequency of missing data to determine if the frequency of missing data for an item was high (i.e., 10 percent or higher). Items with missing at a high frequency were examined for trends of random or systematically missing data to note in the results. Specifically, data not missing at random would warrant further examination (Enders, 2010). Due to the nature of a forced-choice online data collection format, the data did not necessitate screening for out-of-range values. Further, because of the ordinal nature of Likert-type responses collected for the variables of interest and the meaningfulness of analyzing all individuals' responses (even at the extremes), tests of skewness and kurtosis were not used. In addition, the use of confirmatory factor analysis (CFA) estimates has no assumption of normality among the data.

Hypothesis 1: Frequency of Use Predicting Use-Related Problems

To test the hypothesized relationships between frequency of use and use-related problems, we conducted four linear regression analyses. Past 30-day alcohol use, marijuana use, and SAM use served as individual independent variables. RAPI scores served as the dependent variable for frequency of alcohol use; MPI scores served as the dependent variable for frequency of marijuana use; and frequency of SAM use was entered into two separate regressions predicting RAPI and MPI scores. To correct for Type I error, a Bonferroni correction of $p < .01$ was utilized (Bonferroni, 1936).

Hypothesis 2: Confirmatory Factor Analysis (CFA) Models

Model Identification. Confirmatory factor models were estimated with M-Plus Version 8.2 (Muthén & Muthén, 1998-2011) using the covariance matrix as the matrix of associations that was analyzed. A 11-factor model and two 10-factor models (i.e., testing

the fit for MNSI items on CNF and PSI latent variables) were tested separately for the alcohol-only and SAM motive groups. This analysis allowed the theoretical model derived in the pilot study of the MUSQ to be tested against the observed data in this study. To identify the model and set the scale, the loading for the first item from each factor was fixed to unity and variances of item residuals were fixed to unity.

Model Fit. We evaluated several indices to determine model fit. Acceptable model fit was considered with Comparative Fit Index (CFI; Bentler, 1990) values greater than or equal to .90 and Root Mean Square Error of Approximation (RMSEA; Steiger & Lind, 1980) values less than or equal to .10 (Weston & Gore, 2006). Excellent fit was considered with CFI values .95 or higher and .06 or lower for RMSEA (Hu & Bentler, 1999) The chi-square test statistic was not used as a goodness-of-fit statistic due to its sensitivity to sample size (Bentler & Bonnet, 1980); however, it was reported for as per the standard convention for CFA results. For models with less than acceptable fit, we examined standardized factor pattern coefficients of items on hypothesized factors and associated modification indices to determine whether theoretically relevant post-hoc modifications could be made to the model to achieve acceptable fit and determine the most appropriate baseline model. Given the data were likely to be skewed and the MUSQ response format yields ordinal data, models were run using the weighted least squares mean and variance adjusted (WLSMV) estimation.

Hypothesis 3: Internal Consistency of the MUSQ Scales

Upon determining the baseline model, we evaluated internal consistency of the MUSQ factor-derived subscales. Internal consistency reliability was evaluated for

alcohol-only, marijuana-only, and SAM groups, as well as the total sample, using Cronbach's alpha and computation of the range and mean of item-scale correlations.

Hypothesis 4: Measurement Invariance of the MUSQ Across Substance Groups

Criteria Used to Evaluate Fit. Measurement invariance of the MUSQ was tested using the first three (of four) sequentially restrictive steps described by Widaman and Reiss (1997) reflecting tests of (1) configural, (2) metric, and (3) scalar invariance. The fourth step, testing invariance of residuals, was excluded from analyses because it is not necessary for, and does not have an effect on, examining differences in latent means (Vandenberg & Lance, 2000). A series of nested multiple group confirmatory factor analysis (MGCFA) models with sequentially greater numbers of group invariance constraints were estimated using M-Plus Version 8.2 (Muthén & Muthén, 1998-2011). The best-fitting model identified in the individual group CFAs was used as the baseline model. To test for measurement invariance across groups, the fit indices used to evaluate the models in the baseline CFAs (CFI and RMSEA) were also examined in all tests of invariance. In addition, the difference in fit of the more constrained model was compared with that of the next less constrained model. Evidence for non-invariance was assessed by a decrease in CFI greater than or equal to .01 and an increase in RMSEA of .015 or greater (Chen, 2007). The chi-square difference test statistics were reported, although they were not used as criteria for measurement invariance due to their sensitivity to sample sizes. Chi-square statistics that yield a nonsignificant value simply suggest insufficient information to reject the null hypothesis, which does not then indicate equivalence, per se (Cheung & Rensvold, 2002; Counsell, Cribbie, & Flora, 2020). To identify the models, one factor pattern coefficient per factor was fixed to unity in both

groups. For mean structure analyses, the latent factor means were fixed to zero in one group and freed for estimation in the comparison group.

Configural Invariance. Configural invariance was tested to determine whether the pattern of loadings of items on the MUSQ latent factors was invariant across substance groups (i.e., alcohol-only and SAM users). For this multiple-groups model, the baseline model was tested with the two groups simultaneously, with the same number of factors and same pattern of zero and non-zero loadings, but with no equality constraints on the values of any of the model parameters.

Metric Invariance. If configural invariance is achieved, metric invariance can be tested to determine whether items contribute to the MUSQ latent factors to the same degree across groups. To test this level of invariance, equality constraints are placed on matched-item factor loadings across groups. The fit of the metric model is compared to the fit of the configural model. If the fit of the metric model is not worsened to a notable degree compared to the configural model (i.e., $\Delta RMSEA \geq .015$, $\Delta CFI \leq .01$), it is concluded that metric invariance is demonstrated. If passed, invariance at this level suggests that any group differences in factor variances and covariances are true differences due to group membership, not a bias in measurement.

Scalar Invariance. If metric invariance is achieved, scalar invariance can be tested to establish whether item thresholds differ across groups. To test this level of invariance, equality constraints are placed on matched-item intercepts across groups. The fit of the scalar model is compared to the fit of the metric model. If the fit of the scalar model is not worsened to a notable degree compared to the metric model (i.e., $\Delta RMSEA \geq .015$, $\Delta CFI \leq .01$), it is concluded that scalar invariance is demonstrated. If this level of

invariance is passed, differences in latent factor means can be concluded to be due to true differences across groups rather than a bias in measurement.

Partial Invariance. In the event of evidence for non-invariance, partial invariance is considered at the metric and scalar level in order to allow for examination of subsequent mean differences among the latent factors using only those factors that are deemed at least partially invariant. Partial invariance is determined by examining the sources of non-invariance through modification indices and sequentially releasing constraints (on the factor loadings or thresholds) until a partially invariant model emerges (Jung & Yoon, 2016). Partial invariance is passed if the majority of items on a factor are invariant (Steenkamp & Baumgartner, 1998; Vandenberg & Lance, 2000).

Hypothesis 5: Mean Differences in MUSQ Latent Factors

If scalar invariance is demonstrated, group latent factor means are compared by setting the latent factor variance to zero for one group and allowing the same latent factor in the respective comparison group to vary. The standardized mean in the comparison group, if statistically significant, represents the standard deviation difference in the comparison group relative to the reference group (Putnick & Bornstein, 2016).

Hypothesis 6: MUSQ Motives Predicting Use-Related Problems

To determine whether endorsement of substance-class-specific MUSQ motive Frequency scales predict use-related problems, we conducted four multiple regressions. For the first model, MUSQ motive Frequency scales completed in reference to alcohol use served as the independent variables and RAPI scores served as the dependent variable. For the second model, Marijuana MUSQ motive Frequency scales were independent variables and MPI scores were the dependent variable. For the third and

fourth models, SAM Motive Frequency scales served as independent variables predicting RAPI and MPI scores in separate analyses. To correct for Type I error, a Bonferroni correction of $p < .01$ was utilized. These analyses, if the hypothesis is supported, provided initial evidence for the construct validity of the MUSQ scale scores.

CHAPTER III – RESULTS

Data Preparation

Of the total sample of those who consented to the study (*N* = 1670), 21 participants were excluded due to indicating they were under the age of 18 years. Ninety participants were excluded due to indicating they had not used alcohol or marijuana in the past month. Finally, an additional 549 responses were excluded from analyses due to failure to pass validity checks. Thus, the final sample consisted of 1010 participants (see Table 1 for demographic characteristics). As expected, there were significantly more past-month alcohol users (*n* = 461) and SAM users (*n* = 374) than marijuana-only and concurrent alcohol and marijuana users (n = 175). Despite efforts to recruit and capture a marijuana subsample, this group was underpowered for CFA and invariance testing analyses to interpret meaningful results. As such, two-group (alcohol [i.e., ALC] and SAM) difference testing was conducted.

Table 1 *Demographics*

	n	%	Min	Max	M	SD
Age			18	71	24.56	7.34
Gender						
Female	562	55.6				
Male	404	40.0				
Genderqueer / gender non-conforming	18	1.8				
Cisgender	8	0.8				
Transman	5	0.5				
Other	5	0.5				
Prefer not to say	5	0.5				
Transwoman	3	0.3				

Table 1 (continued).

Marital Status		
Single	725	71.8
Married	176	17.4
Engaged	60	5.9
Divorced	23	2.3
Prefer not to say	20	2.0
Separated	4	0.4
Widowed	2	0.2
Race / Ethnicity		
White	676	66.9
Black	130	12.9
Other / biracial / multiracial	58	5.7
American Indian / Alaska Native	44	4.4
Hispanic / Spanish / LatinX	42	4.2
East Asian / Asian American	25	2.5
Prefer not to say	13	1.3
South Asian / Indian American	12	1.2
Middle Eastern / Arab American	9	0.9
Pacific Islander	1	0.1
Education		
Some college, no degree	428	42.4
Bachelor's degree	173	17.1
Graduated high school or equivalent	166	16.4
Associate degree	130	12.9
Master's degree	56	5.5
12^{th} grade or less	28	2.8
Doctoral or professional degree	16	1.6
Prefer not to say	13	1.3
Recruitment Method		
Social media	572	56.6
USM	438	43.4

Next, we examined frequencies for all variables of interest (i.e., frequency of use, MUSQ items, and RAPI and MPI items by respective substance group; Table 2). No variables were missing more than ten percent of data. Frequencies of missing MUSQ item data ranged from 0.2 to 1.4 percent. Frequencies of missing frequency of use data ranged from 0.0 to 0.2 percent. Frequencies of missing RAPI and MPI items ranged from 0.9 to 4.8 percent and 2.9 to 7.0 percent, respectively. Therefore, none warranted exclusion or further examination.

Table 2 *Descriptive Statistics for Variables of Interest*

	n	%	Min	Max	*M*	SD	α
Substance group							
ALC	461	45.6					
Marijuana	175	17.3					
SAM	374	37.0					
RAPI							
Total across groups	1053		0.0	72.0	14.20	13.59	.957
MPI							
Total across groups	676		0.0	72.0	16.98	13.69	.933
Alcohol group							
Frequency of use	461		1.0	8.0	3.35	1.52	
Frequency of binge drinking	459		0.0	7.0	1.75	1.57	
RAPI	440		0.0	59.0	8.81	11.16	.950
Marijuana group							
Frequency of use	175		1.0	8.0	4.41	2.66	
MPI	163		0.0	50.0	9.91	11.02	.900
SAM group							
Frequency of use	374		1.0	8.0	2.90	1.62	
RAPI	340		0.0	66.6	14.10	13.26	.944
MPI	336		0.0	62.0	16.13	13.13	.920

Abbreviations: ALC, alcohol group; SAM, simultaneous alcohol and marijuana users; RAPI, Rutgers Alcohol Problem Index; MPI, Marijuana Problem Index.

Hypothesis 1: Frequency of Use Predicting Use-Related Problems

We conducted four linear regression analyses to test the hypothesized relationships between frequency of use and use-related problems. Table 3 presents the results of the analyses. For the models, sample sizes ranged from 336 to 780. All models were statistically significant with a Bonferroni correction of $p < .01$. Past-month frequency of alcohol use accounted for 26.5 percent of the variance in alcohol use-related problems. Past-month frequency of marijuana use accounted for 6.5 percent of the variance in marijuana use-related problems. Finally, past-month SAM use accounted for 9.8 and 11.4 percent of the variance in marijuana and alcohol use-related problems, respectively. Standardized betas ranged from .255 to .515. As expected, greater frequency of use predicted a greater degree of associated substance use problems.

Table 3 *Linear Regression Analyses for Frequency of Use Predicting Use-Related Problems*

	n	R^2	*B*	*SE B*	β	*t*	*p*
Model 1 (RAPI)	780	.265					<.001*
(constant)			-1.973	.869		-2.271	.023
Alcohol Use Frequency			3.781	.226	.515	16.761	<.001*
Model 2 (MPI)	498	.065					<.001*
(constant)			7.942	1.191		6.669	<.001*
Marijuana Use Frequency			1.377	.235	.255	5.873	<.001*
Model 3 (RAPI)	340	.114					<.001*
(constant)			6.083	1.390		4.378	<.001*
SAM Use Frequency			2.802	.424	.338	6.610	<.001*
Model 4 (MPI)	336	.098					<.001*
(constant)			8.747	1.404		6.230	<.001*
SAM Use Frequency			2.548	.423	.313	6.018	<.001*

Note: * Significant with Bonferroni correction of $p < .01$

Abbreviations: SAM, simultaneous alcohol and marijuana users; RAPI, Rutgers Alcohol Problem Index; MPI, Marijuana Problem Index.

Hypothesis 2: Confirmatory Factor Analysis (CFA) Models

For the hypothesized 11-factor and two 10-factor models, all of the resulting latent variable covariance matrices were non-positive definite. Non-positive definite latent variable covariances can be due to negative factor variance or linear dependency among two or more of the latent factors (Wothke, 1993). We requested the M-Plus "Tech 4" output for the models in order to investigate the reason for the non-positive definite matrices. All factor variances were positive and non-zero. Next, we examined the latent factor correlations which are presented in Tables 4-9. There were high correlations across most of the latent factors. As outlined below, frequency and magnitude of high correlations among the latent factors suggested a higher-order motivation factor.

In the 11-factor model, correlations among the latent factors for the SAM group ranged from .492 to .952, with 11 latent factor correlations .85 or higher (Table 4). Latent factor correlations for the ALC group ranged from .603 to .993, with 21 correlations .85 or higher (Table 5). In the 10-factor model combining indicators for MNSI and PSI, correlations among the latent factors for the SAM group ranged from .492 to .952, with eight latent factor correlations .85 or higher (Table 6). Latent factor correlations for the ALC group ranged from .604 to .993, with 20 correlations .85 or higher (Table 7). Finally, in the hypothesized 10-factor model combining indicators for MNSI and CNF, correlations among the latent factors for the SAM group ranged from .492 to .952, with eight correlations .85 or higher (Table 8). Latent factor correlations for the ALC group ranged from .603 to .993, with 20 correlations .85 or higher (Table 9).

Table 4 *SAM Latent Factor Correlations for Hypothesized 11-Factor Model*

	RAUA	CNF	EOS	RLR	PSI	REB	APEP	IPA	MNSI	RNA	SUB
RAUA	---										
CNF	.528	---									
EOS	.520	.841	---								
RLR	.561	.683	.712	---							
PSI	.619	.903	.723	.640	---						
REB	.492	.892	.837	.648	.791	---					
APEP	.632	.869	.815	.703	.852	.856	---				
IPA	.833	.612	.572	.593	.856	.602	.781	---			
MNSI	.665	.884	.824	.638	.793	.817	.795	.634	---		
RNA	.830	.807	.719	.649	.749	.717	.724	.793	.829	---	
SUB	.534	.915	.952	.691	.740	.881	.824	.527	.849	.760	---

Abbreviations: SAM, simultaneous alcohol and marijuana users; RAUA, factor 1, Reduce Anxiety / Unpleasant Arousal; CNF, factor 2, Conformity; EOS, factor 3, Effects of Other Substances; RLR, factor 4, Relative Low Risk; PSI, factor 5, Positive Social Interactions; REB, factor 6, Rebellion; APEP, factor 7, Altered Perceptions / Experiential Processes; IPA, factor 8, Increase Positive Affect; MNSI, factor 9, Manage Negative Social Interactions; RNA, factor 10, Reduce Negative Affect; SUB, factor 11, Substitution.

Table 5 *ALC Latent Factor Correlations for Hypothesized 11-Factor Model*

	RAUA	CNF	EOS	RLR	PSI	REB	APEP	IPA	MNSI	RNA	SUB
RAUA	---										
CNF	.688	---									
EOS	.621	.836	---								
RLR	.716	.814	.886	---							
PSI	.759	.859	.636	.734	---						
REB	.682	.854	.877	.852	.732	---					
APEP	.747	.867	.879	.854	.816	.876	---				
IPA	.885	.729	.603	.778	.900	.730	.821	---			
MNSI	.712	.897	.906	.798	.763	.836	.907	.707	---		
RNA	.887	.831	.819	.796	.735	.781	.856	.858	.876	---	
SUB	.615	.869	.993	.884	.678	.884	.921	.609	.920	.826	---

Abbreviations: ALC, alcohol-only users; RAUA, factor 1, Reduce Anxiety / Unpleasant Arousal; CNF, factor 2, Conformity; EOS, factor 3, Effects of Other Substances; RLR, factor 4, Relative Low Risk; PSI, factor 5, Positive Social Interactions; REB, factor 6, Rebellion; APEP, factor 7, Altered Perceptions / Experiential Processes; IPA, factor 8, Increase Positive Affect; MNSI, factor 9, Manage Negative Social Interactions; RNA, factor 10, Reduce Negative Affect; SUB, factor 11, Substitution.

Table 6 *SAM Latent Factor Correlations for Hypothesized 10-Factor Model (MNSI+PSI)*

	RAUA	CNF	EOS	RLR	MSNI + PSI	REB	APEP	IPA	RNA	SUB
RAUA	---									
CNF	.528	---								
EOS	.520	.841	---							
RLR	.561	.683	.712	---						
MNSI + PSI	.655	.933	.787	.664	---					
REB	.492	.892	.837	.648	.832	---				
APEP	.632	.869	.815	.703	.869	.856	---			
IPA	.833	.612	.572	.593	.839	.602	.782	---		
RNA	.830	.807	.719	.648	.804	.717	.724	.793	---	
SUB	.534	.915	.952	.691	.812	.881	.824	.527	.760	---

Abbreviations: SAM, simultaneous alcohol and marijuana users; RAUA, factor 1, Reduce Anxiety / Unpleasant Arousal; CNF, factor 2, Conformity; EOS, factor 3, Effects of Other Substances; RLR, factor 4, Relative Low Risk; MNSI+PSI, factor 5, Manage Negative Social Interactions and Positive Social Interactions; REB, factor 6, Rebellion; APEP, factor 7, Altered Perceptions / Experiential Processes; IPA, factor 8, Increase Positive Affect; RNA, factor 9, Reduce Negative Affect; SUB, factor 10, Substitution.

Table 7 *ALC Latent Factor Correlations for Hypothesized 10-Factor Model (MNSI+PSI)*

	RAUA	CNF	EOS	RLR	MSNI + PSI	REB	APEP	IPA	RNA	SUB
RAUA	---									
CNF	.688	---								
EOS	.621	.836	---							
RLR	.716	.814	.886	---						
MNSI + PSI	.776	.898	.779	.776	---					
REB	.682	.854	.877	.852	.790	---				
APEP	.747	.867	.879	.854	.871	.876	---			
IPA	.885	.729	.604	.778	.897	.730	.821	---		
RNA	.887	.831	.819	.796	.805	.781	.856	.858	---	
SUB	.615	.869	.993	.884	.809	.884	.921	.610	.826	---

Abbreviations: SAM, simultaneous alcohol and marijuana users; RAUA, factor 1, Reduce Anxiety / Unpleasant Arousal; CNF, factor 2, Conformity; EOS, factor 3, Effects of Other Substances; RLR, factor 4, Relative Low Risk; MNSI+PSI, factor 5, Manage Negative Social Interactions and Positive Social Interactions; REB, factor 6, Rebellion; APEP, factor 7, Altered Perceptions / Experiential Processes; IPA, factor 8, Increase Positive Affect; RNA, factor 9, Reduce Negative Affect; SUB, factor 10, Substitution.

Table 8 *SAM Latent Factor Correlations for Hypothesized 10-Factor Model (MNSI+CNF)*

	RAUA	MNSI + CNF	EOS	RLR	PSI	REB	APEP	IPA	RNA	SUB
RAUA	---									
MNSI + CNF	.593	---								
EOS	.520	.856	---							
RLR	.561	.685	.712	---						
PSI	.620	.893	.723	.640	---					
REB	.492	.890	.837	.648	.791	---				
APEP	.632	.867	.815	.703	.852	.856	---			
IPA	.833	.635	.572	.593	.856	.602	.781	---		
RNA	.830	.835	.719	.649	.749	.717	.724	.793	---	
SUB	.535	.917	.952	.691	.740	.881	.824	.527	.760	---

Abbreviations: SAM, simultaneous alcohol and marijuana users; RAUA, factor 1, Reduce Anxiety / Unpleasant Arousal; MNSI+CNF, factor 2, Manage Negative Social Interactions and Conformity; EOS, factor 3, Effects of Other Substances; RLR, factor 4, Relative Low Risk; PSI, factor 5, Positive Social Interactions; REB, factor 6, Rebellion; APEP, factor 7, Altered Perceptions / Experiential Processes; IPA, factor 8, Increase Positive Affect; RNA, factor 9, Reduce Negative Affect; SUB, factor 10, Substitution.

Table 9 *ALC Latent Factor Correlations for Hypothesized 10-Factor Model (MNSI+CNF)*

	RAUA	MNSI + CNF	EOS	RLR	PSI	REB	APEP	IPA	RNA	SUB
RAUA	---									
MNSI + CNF	.713	---								
EOS	.621	.887	---							
RLR	.716	.827	.886	---						
PSI	.759	.848	.636	.734	---					
REB	.682	.868	.877	.852	.732	---				
APEP	.747	.905	.879	.854	.816	.876	---			
IPA	.885	.738	.603	.778	.900	.730	.821	---		
RNA	.887	.869	.819	.796	.735	.781	.856	.858	---	
SUB	.615	.912	.993	.884	.678	.884	.921	.609	.826	---

Abbreviations: SAM, simultaneous alcohol and marijuana users; RAUA, factor 1, Reduce Anxiety / Unpleasant Arousal; MNSI+CNF, factor 2, Manage Negative Social Interactions and Conformity; EOS, factor 3, Effects of Other Substances; RLR, factor 4, Relative Low Risk; PSI, factor 5, Positive Social Interactions; REB, factor 6, Rebellion; APEP, factor 7, Altered Perceptions / Experiential Processes; IPA, factor 8, Increase Positive Affect; RNA, factor 9, Reduce Negative Affect; SUB, factor 10, Substitution.

More detailed examination of the latent variable relationships revealed a very large and consistent correlation between factor 3 (Effects of Other Substances; EOS) and factor 11 (Substitution; SUB) for the SAM group (r = .952) and ALC group (r = .993), suggesting the items in these factors may theoretically represent the same underlying latent variable (i.e., broadly managing the effects of substances). Anchoring items from these factors under one latent variable in 10-factor models nevertheless continued to produce a non-positive definite covariance matrix. We then examined the hypothesized alternative models (i.e., 9-factor models testing fit for MNSI indicators on the Positive Social Interactions [PSI] and on the Conformity [CNF] latent variable) with EOS and SUB items combined under one latent variable; however, this continued to produce a non-positive definite covariance matrix. As such, we created a higher-order latent factor which allowed for a positive definite matrix in all subsequent models.

Confirmatory Factor Models with Higher-Order Motivation Factor

For the 11-factor models (Model 1) we included all 81 MUSQ items examined in this study and anchored the two new split indicators (i.e., “To avoid conflict with others” and “To manage conflict with others”) within their originally hypothesized latent variable (i.e., factor 9; Manage Negative Social Interactions; MNSI). For the ALC group, fit statistics demonstrated slightly less-than-acceptable fit (CFI = .889; RMSEA = .071), $\chi 2$ (df = 3148) = 10522.746, $p < .001$. For the SAM group, fit statistics similarly demonstrated less-than-acceptable fit (CFI = .874; RMSEA = .075), $\chi 2$ (df = 3148) = 9845.438, $p < .001$.

We examined the hypothesized 10-factor models by testing the fit for MNSI indicators on the Positive Social Interactions (factor 5; PSI) latent variable (Model 2). For

the ALC group, fit statistics demonstrated slightly less-than-acceptable fit (CFI = .886; RMSEA = .072), $\chi 2$ (df = 3149) = 10743.713, $p < .001$. For the SAM group, fit statistics similarly demonstrated less-than-acceptable fit (CFI = .872; RMSEA = .076), $\chi 2$ (df = 3149) = 9952.055, $p < .001$.

Next, we examined the second hypothesized 10-factor models by testing the fit for MNSI indicators on the CNF latent variable (Model 3). For the ALC group, fit statistics demonstrated slightly less-than-acceptable fit (CFI = .889; RMSEA = .071), $\chi 2$ (df = 3149) = 10527.942, $p < .001$. For the SAM group, fit statistics similarly demonstrated less-than-acceptable fit (CFI = .874; RMSEA = .076), $\chi 2$ (df = 3149) = 9869.008, $p < .001$.

At this point in the analyses, Models 1, 2, and 3 were comparable in fit, with Models 2 and 3 being the more parsimonious models across substance groups. To determine whether one model would demonstrate better fit compared to the others, we examined modification indices across the models. Examination of modification indices revealed five items (Item 10 – To reduce feelings of fear; Item 12 – to feel like nothing can bother me; Item 36 – To enjoy social interactions; Item 60 – To have fun; and Item 61 – To celebrate) cross-loaded at a significant magnitude across models and substance groups. As such, we excluded these items and examined the models again for SAM and ALC users (Models 4, 5, and 6). The 11-factor model (Model 4) revealed increased fit for the ALC group (CFI = .922; RMSEA = .063), $\chi 2$ (df = 2763) = 7744.272, $p < .001$, and SAM group (CFI = .893; RMSEA = .073), $\chi 2$ (df = 2763) = 8311.504, $p < .001$. The two 10-factor models (Models 5 and 6) also revealed comparable increased fit for combining MNSI and PSI in the ALC group (CFI = .918; RMSEA = .064), $\chi 2$ (df = 2764) =

7945.623, $p < .001$, and SAM group (CFI = .891; RMSEA = .074), $\chi 2$ ($df = 2764$) = 8407.127, $p < .001$, as well as combining MNSI and CNF in the ALC group (CFI = .915; RMSEA = .065), $\chi 2$ ($df = 2764$) = 8160.469, $p < .001$, and SAM group (CFI = .884; RMSEA = .076), $\chi 2$ ($df = 2764$) = 8739.434, $p < .001$.

Examination of the modification indices in these models revealed combining items from Reduce Anxiety Unpleasant Arousal (Factor 1; RAUA) and Increase Positive Affect (Factor 8; IPA) would increase the fit of the models for the SAM group and, to a lesser extent, the ALC group. The 10-factor model (i.e., combining RAUA with IPA and excluding items 10, 12, 36, 60, and 61; Model 7) revealed slightly increased fit for the SAM group (CFI = .898; RMSEA = .071), $\chi 2$ ($df = 2764$) = 8015.440, $p < .001$, but comparable fit compared to the 11-factor model (Model 4) for the ALC group (CFI = .922; RMSEA = .062), $\chi 2$ ($df = 2764$) = 7691.276, $p < .001$. A similar pattern was observed in comparing the 9-factor model of combining MNSI with PSI, excluding items 10, 12, 36, 60, and 61, and combining RAUA with IPA (Model 8) to the same model with RAUA and IPA as separate latent factors (Model 5), such that fit improved for the SAM group (CFI = .897; RMSEA = .072), $\chi 2$ ($df = 2765$) = 8107.323, $p < .001$ but remained comparable for ALC group (CFI = .919; RMSEA = .063), $\chi 2$ ($df = 2765$) = 7883.210, $p < .001$. Finally, the 9-factor model of combining MNSI with CNF, excluding items 10, 12, 36, 60, and 61, and combining RAUA with IPA (Model 9) to the same model with RAUA and IPAA as separate latent factors (Model 6) revealed slightly increased fit across the SAM group (CFI = .898; RMSEA = .071), $\chi 2$ ($df = 2765$) = 8045.108, $p < .001$, and ALC group (CFI = .922; RMSEA = .062), $\chi 2$ ($df = 2765$) = 7705.223, $p < .001$ and comparable fit to the 10-factor model combining RAUA with IPA and dropping the

five items across groups (Model 7). Therefore, prior to additional post-hoc modifications through examination of modification indices, we established Model 9 as the preliminary baseline model for both SAM and ALC groups based on (a) the strength of model fit and (b) parsimony of latent variables.

Examination of modification indices for ALC and SAM groups in Model 9 revealed one item warranted exclusion based on large and double loadings on latent variables to improve fit: Item 8 – To relax, loosen up, or unwind. We dropped this item from Model 9 (Model 10), which improved fit for the ALC group (CFI = .927; RMSEA = .061), $\chi 2$ (df = 2691) = 7304.954, $p < .001$, and SAM group (CFI = .905; RMSEA = .070), $\chi 2$ (df = 2691) = 7582.684, $p < .001$, demonstrating acceptable fit across groups.

Examination of modification indices for ALC and SAM groups in Model 10 revealed two items warranted exclusion based on large and double loadings on latent variables to substantially improve fit for the SAM group and, to a lesser extent, the ALC group: Item 68 – To feel more confident or effective and Item 69 – To improve my self-esteem. We dropped these items from Model 10 (Model 11), which further improved fit for the ALC group (CFI = .932; RMSEA = .060), $\chi 2$ (df = 2546) = 6750.300, $p < .001$, and SAM group (CFI = .915; RMSEA = .067), $\chi 2$ (df = 2546) = 6783.668, $p < .001$.

Examination of the modification indices in Model 11 revealed combining items from the new latent factor (Factor 1 – combining indicators from RAUA and IPA) with Factor 10 (Reduce Negative Affect; RNA) would substantially increase the fit of the models for the SAM group and ALC group. This theoretically sound parsimonious modification, accounting for motives related to managing emotional states (Model 12), revealed increased fit for the ALC group (CFI = .934; RMSEA = .059), $\chi 2$ (df = 2547) =

6630.123, $p < .001$, and similar fit for SAM group (CFI = .913; RMSEA = .067), $\chi 2$ (df = 2547) = 6868.491, $p < .001$, compared to the 9-factor model (Model 11).

Examination of modification indices for ALC and SAM groups in Model 12 revealed two items warranted exclusion based on large and double loadings on latent variables: Item 3 – To feel less stressed and Item 73 – To feel less ashamed. We dropped these items from Model 12 (Model 13), which improved fit for both the ALC group (CFI = .938; RMSEA = .058), $\chi 2$ (df = 2406) = 6113.691, $p < .001$, and SAM group (CFI = .920; RMSEA = .066), $\chi 2$ (df = 2406) = 6267.718, $p < .001$.

Examination of modification indices for ALC and SAM groups in Model 13 revealed one item warranted exclusion based on large and double loadings on latent variables: Item 76 – To feel less guilty. We dropped this item from Model 13 (Model 14), which improved fit for both the SAM group (CFI = .924; RMSEA = .064), $\chi 2$ (df = 2337) = 5941.699, $p < .001$, and demonstrated similar fit for the ALC group (CFI = .938; RMSEA = .058), $\chi 2$ (df = 2337) = 5951.637, $p < .001$, compared to Model 13.

Finally, examination of modification indices for ALC and SAM groups in Model 14 revealed one item warranted exclusion based on large and double loadings on latent variables: Item 38 – To celebrate with others. We dropped this item from Model 14 (Model 15), which slightly improved fit for both the SAM group (CFI = .926; RMSEA = .064), $\chi 2$ (df = 2269) = 5768.028, $p < .001$, and ALC group (CFI = .942; RMSEA = .057), $\chi 2$ (df = 2269) = 5632.319, $p < .001$, compared to Model 14. Thus, Model 15 – the 8-factor model with a higher-order motivation factor; MNSI and CNF items combined into one latent factor (broadly managing negative social interactions; MNSI-r); RAUA, IPA, and RNA items combined into one latent factor (broadly managing emotional states;

MES) and removing Items 3, 8, 10, 12, 36, 60, 61, 68, 69, 73, and 76 – was established as the baseline model with acceptable fit based on CFI and RMSEA for the SAM group and acceptable and excellent fit based on CFI and RMSEA, respectively, for the ALC group (See Table 10 for all alternative baseline model fit statistics).

Table 10 *CFA Baseline Model Fit Statistics for ALC and SAM Users' MUSQ Responses*

	Fit Indices				
Model	$\chi 2$	*df*	*p*	RMSEA	CFI
Model 1	10522.746	3148	<.001	.071	.889
ALC: 11-factor w/ HO factor	9845.438	3148	<.001	.075	.874
SAM: 11-factor w/ HO factor					
Model 2					
ALC: 10-factor w/ HO factor (MNSI+PSI)	10743.713	3149	<.001	.072	.886
SAM: 10-factor w/ HO factor (MNSI+PSI)	9952.055	3149	<.001	.076	.872
Model 3					
ALC: 10-factor w/ HO factor (MNSI+CNF)	10527.942	3149	<.001	.071	.889
SAM: 10-factor w/ HO factor (MNSI+CNF)	9869.008	3149	<.001	.076	.874
Model 4					
ALC: 11-factor w/ HO factor (drop Items 10, 12, 36, 60, and 61)	7744.272	2763	<.001	.063	.922
SAM: 11-factor w/ HO factor (drop Items 10, 12, 36, 60, and 61)	8311.504	2763	<.001	.073	.893
Model 5					
ALC: 10-factor w/ HO factor (MNSI+PSI; drop Items 10, 12, 36, 60, and 61)	7945.623	2764	<.001	.064	.918
SAM: 10-factor w/ HO factor (MNSI+PSI; drop Items 10, 12, 36, 60, and 61)	8407.127	2764	<.001	.074	.891
Model 6					
ALC: 10-factor w/ HO factor (MNSI+CNF; drop Items 10, 12, 36, 60, and 61)	8160.469	2764	<.001	.065	.915
SAM: 10-factor w/ HO factor (MNSI+CNF; drop Items 10, 12, 36, 60, and 61)	8739.434	2764	<.001	.076	.884

Table 10 (continued).

Model 7					
ALC: 10-factor w/ HO factor (RAUA+IPA; drop Items 10, 12, 36, 60, and 61)	7691.276	2764	<.001	.062	.922
SAM: 10-factor w/ HO factor (RAUA+IPA; drop Items 10, 12, 36, 60, and 61)	8015.440	2764	<.001	.071	.898
Model 8					
ALC: 9-factor w/ HO factor (MNSI+PSI and RAUA+IPA; drop Items 10, 12, 36, 60, and 61)	7883.210	2765	<.001	.063	.919
SAM: 9-factor w/ HO factor (MNSI+PSI and RAUA+IPA; drop Items 10, 12, 36, 60, and 61)	8107.323	2765	<.001	.072	.897
Model 9					
ALC: 9-factor w/ HO factor (MNSI+CNF and RAUA+IPA; drop Items 10, 12, 36, 60, and 61)	7705.223	2765	<.001	.062	.922
SAM: 9-factor w/ HO factor (MNSI+CNF and RAUA+IPA; drop Items 10, 12, 36, 60, and 61)	8045.108	2765	<.001	.071	.898
Model 10					
ALC: 9-factor w/ HO factor (MNSI+CNF and RAUA+IPA; drop Items 8, 10, 12, 36, 60, and 61)	7304.954	2691	<.001	.061	.927
SAM: 9-factor w/ HO factor (MNSI+CNF and RAUA+IPA; drop Items 8, 10, 12, 36, 60, and 61)	7582.684	2691	<.001	.070	.905
Model 11					
ALC: 9-factor w/ HO factor (MNSI+CNF and RAUA+IPA; drop Items 8, 10, 12, 36, 60, 61, 68, and 69)	6750.300	2546	<.001	.060	.932
SAM: 9-factor w/ HO factor (MNSI+CNF and RAUA+IPA; drop Items 8, 10, 12, 36, 60, 61, 68, and 69)	6783.668	2546	<.001	.067	.915

Table 10 (continued).

Model 12					
ALC: 8-factor w/ HO factor (MNSI+CNF and RAUA+IPA+RNA; drop Items 8, 10, 12, 36, 60, 61, 68, and 69)	6630.123	2547	<.001	.059	.934
SAM: 8-factor w/ HO factor (MNSI+CNF and RAUA+IPA+RNA; drop Items 8, 10, 12, 36, 60, 61, 68, and 69)	6868.491	2547	<.001	.067	.913
Model 13					
ALC: 8-factor w/ HO factor (MNSI+CNF and RAUA+IPA+RNA; drop Items 3, 8, 10, 12, 36, 60, 61, 68, 69 and 73)	6113.691	2406	<.001	.058	.938
SAM: 8-factor w/ HO factor (MNSI+CNF and RAUA+IPA+RNA; drop Items 3, 8, 10, 12, 36, 60, 61, 68, 69 and 73)	6267.718	2406	<.001	.066	.920
Model 14					
ALC: 8-factor w/ HO factor (MNSI+CNF and RAUA+IPA+RNA; drop Items 3, 8, 10, 12, 36, 60, 61, 68, 69, 73, and 76)	5951.637	2337	<.001	.058	.938
SAM: 8-factor w/ HO factor (MNSI+CNF and RAUA+IPA+RNA; drop Items 3, 8, 10, 12, 36, 60, 61, 68, 69, 73, and 76)	5941.699	2337	<.001	.064	.924
Model 15					
ALC: 8-factor w/ HO factor (MNSI+CNF and RAUA+IPA+RNA; drop Items 3, 8, 10, 12, 36, 38, 60, 61, 68, 69, 73, and 76)	5632.319	2269	<.001	.057	.942
SAM: 8-factor w/ HO factor (MNSI+CNF and RAUA+IPA+RNA; drop Items 3, 8, 10, 12, 36, 38, 60, 61, 68, 69, 73, and 76)	5768.028	2269	<.001	.064	.926

Hypothesis 3: Internal Consistency of the MUSQ Scales

Internal consistency reliability was evaluated for the 8-factor baseline model with alcohol-only, marijuana-only, and SAM groups, as well as with the total sample. We

examined Cronbach's alpha and the range and mean of corrected item-scale correlations. Tables 11-14 include the means, standard deviations, item-scale correlations, mean item-scale correlations, Cronbach's alphas, and alphas if deleted for all items and factors for the total sample (Table 11) and substance groups (Tables 12-14).

Cronbach's alphas ranged from to .847 (SUB) to .956 (MES; total sample), .879 (RLR) to .957 (MES; alcohol-only), .734 (SUB) to .953 (MES; marijuana-only), and .818 (APEP) to .947 (MNSI-r; SAM). We conducted alpha-if-item-deleted analyses to determine if alphas would greatly improve through deletion of any additional items. Item 33 (i.e., To make social gatherings and parties more fun) would improve the alpha for PSI from .925 by .001 (total sample) and .917 by .002 (alcohol-only). For the alcohol-only group, Item 21 (i.e., To enhance the effects of another drug) would improve the alpha for EOS from .904 by .001. For the marijuana-only group, two items (Item 72 – To manage conflict with others; Item 25 – To help with the side effects of a medication) would improve the alpha for MNSI-r from .915 by .004 and EOS from .883 by .008. Deletion of any other items would decrease or maintain alphas. Because the alphas for PSI, MNSI-r, and EOS were already in the high range, no further items were deleted. All item-scale correlations for the factors across all groups were well above the minimum acceptable value of .30 or higher. Mean item-scale correlations ranged from .627 (APEP) to .760 (MNSI-r; total sample), .686 (APEP) to .810 (EOS; alcohol-only), .534 (APEP) to .728 (MEs; marijuana-only), and .558 (APEP) to .791 (MNSI-r; SAM).

Table 11 *Means, Standard Deviations, Corrected Item-Total Correlations, and Alphas if Deleted for Total Sample MUSQ*

	M	*SD*	*M* r_t	r_t	Cronbach's Alpha	Cronbach's Alpha if Deleted
1. MES (RAUA/IPA/RNA) – 20 items			**.706**		**.956**	
1. To calm down	2.97	1.48		.718		.954
2. To stop worrying	2.85	1.51		.754		.953
4. To release tension	3.31	1.51		.722		.954
5. To feel less on edge	2.96	1.50		.732		.954
6. To reduce feelings of anxiety or nervousness	3.08	1.57		.714		.954
7. To slow down racing thoughts	2.53	1.53		.696		.954
9. To feel less irritable	2.79	1.50		.759		.953
11. To decrease restlessness	2.53	1.49		.660		.955
58. To feel more joy or happiness	3.19	1.56		.749		.953
59. To help me get into a good mood	3.25	1.49		.734		.954
62. To feel more pleasure	3.21	1.53		.634		.955
63. To feel more excited	2.86	1.46		.594		.956
64. To feel content with life	2.76	1.54		.768		.953
65. To feel alive	2.50	1.53		.659		.955
66. To feel less bored	2.98	1.51		.627		.955
67. To feel euphoric or feel at peace	3.18	1.54		.679		.954
74. To reduce feelings of helplessness	2.36	1.52		.737		.954
75. To reduce feeling of hopelessness	2.36	1.51		.761		.953
77. To feel less lonely	2.36	1.45		.699		.954
78. To forget, escape, or avoid my memories	2.50	1.55		.721		.954

Table 11 (continued).

2. MNSI-r (MNSI+CNF) – 9 items			**.760**	**.936**	
13. To not be the only one not doing it	1.78	1.18	.770		.928
14. To satisfy social pressure to use	1.83	1.27	.794		.927
15. To be just like everybody else	1.88	1.25	.794		.927
16. To follow what my friends are doing	1.93	1.21	.724		.931
17. To avoid being made fun of	1.66	1.14	.801		.927
18. To avoid being rejected	1.82	1.23	.764		.928
70. To avoid hurting someone's feelings	1.73	1.18	.751		.929
71. To avoid conflict with others	1.86	1.25	.725		.931
72. To manage conflict with others	1.86	1.22	.713		.931
3. EOS – 7 items			**.759**	**.922**	
19. To counteract the effects of another drug	1.63	1.13	.845		.902
20. To reduce the effects of, or "come down" off of another drug	1.71	1.16	.773		.909
21. To enhance the effects of another drug	1.85	1.24	.686		.918
22. Because I am under the influence of another drug	1.67	1.13	.769		.909
23. To be able to use another drug for a longer period of time	1.61	1.11	.760		.910
24. To reduce the effects of another drug	1.60	1.10	.800		.906
25. To help with the side effects of a medication	1.59	1.12	.677		.918
4. RLR – 6 items			**.681**	**.877**	
26. Because it has fewer side effects than other drugs	2.30	1.56	.717		.849
27. Because it is not as bad for you as other drugs	2.37	1.57	.749		.843
28. Because it does not cause me as many problems as other drugs	2.25	1.56	.747		.844
29. Because I can handle the high better than with some other drugs	1.98	1.40	.631		.864
30. To get high / intoxicated with something I think is safer than other drugs	2.46	1.58	.666		.858
31. Because it is more socially acceptable than other drugs	2.20	1.45	.578		.872

Table 11 (continued).

5. PSI – 11 items		**.700**	**.925**	
32. To help me feel sociable or friendly	2.81	1.46	.726	.917
33. To make social gatherings and parties more fun	3.34	1.51	.546	.926
34. To lose my inhibitions in social situations	2.22	1.34	.634	.921
35. To feel more confident and sure of myself around others	2.56	1.52	.751	.916
37. To have a reason/excuse to socialize	2.37	1.36	.690	.919
39. To feel accepted by others	1.96	1.33	.685	.919
40. To make friends	2.28	1.36	.746	.916
41. To help me relate to others better	2.31	1.36	.742	.916
42. To have a sense of belonging to a social group	2.10	1.31	.713	.918
43. To communicate with others better	2.35	1.41	.732	.917
44. To feel more intimate with, connected to, or closer to others	2.49	1.41	.722	.917
6. REB – 6 items		**.734**	**.902**	
45. To break rules	1.70	1.16	.761	.880
46. To rebel against authority or society	1.70	1.16	.733	.884
47. To do something risky or dangerous	1.72	1.17	.748	.882
48. To do something illegal	1.49	1.02	.698	.890
49. To experience the thrill of doing something I’m not supposed to do	1.91	1.32	.715	.889
50. To do something socially unacceptable	1.63	1.11	.752	.882

Table 11 (continued).

7. APEP – 7 items		**.627**	**.858**	
51. To change my understanding of my perceptions (e.g., a spiritual awakening; special understanding of the universe; realizing the meaning in life)	2.13	1.32	.682	.831
52. To experience a blending of senses (e.g., tasting colors; seeing music as colors or patterns)	2.06	1.35	.684	.830
53. To alter how I perceive my environment (e.g., hear music in greater detail or complexity; enhance or dull sensations; drown out distractions)	2.71	1.58	.621	.840
54. To cause me to perceive things that are not present (i.e., to hallucinate; to see patterns or distortions that are not actually present)	1.74	1.21	.623	.839
55. To seek new experiences	2.60	1.46	.575	.846
56. To help me be more creative	2.36	1.37	.621	.839
57. To know what it's like to be under the influence of these substances	2.04	1.34	.585	.844
8. SUB – 3 items		**.715**	**.847**	
79. To get the same effects as something I'm prescribed when I run out of my prescription	1.63	1.14	.707	.795
80. To get the same amount of the drug I think I need when my doctor won't prescribe enough to me	1.55	1.09	.742	.762
81. To use a drug that is more powerful than one I have gotten used to	1.63	1.13	.696	.805

Abbreviations: MES, factor 1, Manage Emotional States; RAUA, Reduce Anxiety / Unpleasant Arousal; IPA, Increase Positive Affect; RNA, Reduce Negative Affect. MNSI-r, factor 2, Manage Negative Social Interactions-Revised; MNSI, Manage Negative Social Interactions; CNF, Conformity; EOS, factor 3, Effects of Other Substances; RLR, factor 4, Relative Low Risk; PSI, factor 5, Positive Social Interactions; REB, factor 6, Rebellion; APEP, factor 7, Altered Perceptions / Experiential Processes; SUB, factor 8, Substitution.

Table 12 *Means, Standard Deviations, Corrected Item-Total Correlations, and Alphas if Deleted for Alcohol-Only Group MUSQ*

	M	*SD*	*M* r_t	r_t	Cronbach's Alpha	Cronbach's Alpha if Deleted
1. MES (RAUA/IPA/RNA) – 20 items			**.711**		**.957**	
1. To calm down	2.46	1.31		.717		.955
2. To stop worrying	2.51	1.40		.764		.954
4. To release tension	2.88	1.46		.687		.955
5. To feel less on edge	2.61	1.40		.712		.955
6. To reduce feelings of anxiety or nervousness	2.67	1.48		.718		.955
7. To slow down racing thoughts	2.13	1.38		.725		.955
9. To feel less irritable	2.38	1.38		.756		.954
11. To decrease restlessness	2.00	1.25		.666		.956
58. To feel more joy or happiness	2.73	1.44		.724		.955
59. To help me get into a good mood	2.83	1.43		.694		.955
62. To feel more pleasure	2.70	1.49		.639		.956
63. To feel more excited	2.70	1.39		.650		.956
64. To feel content with life	2.36	1.44		.771		.954
65. To feel alive	2.25	1.43		.666		.956
66. To feel less bored	2.52	1.35		.643		.956
67. To feel euphoric or feel at peace	2.48	1.35		.710		.955
74. To reduce feelings of helplessness	2.06	1.32		.737		.955
75. To reduce feeling of hopelessness	1.99	1.31		.745		.955
77. To feel less lonely	2.12	1.37		.741		.955
78. To forget, escape, or avoid my memories	2.17	1.44		.750		.954

Table 12 (continued).

2. MNSI-r (MNSI+CNF) – 9 items			**.728**	**.925**	
13. To not be the only one not doing it	1.84	1.15	.741		.915
14. To satisfy social pressure to use	1.89	1.26	.754		.915
15. To be just like everybody else	1.98	1.23	.742		.915
16. To follow what my friends are doing	2.01	1.20	.650		.921
17. To avoid being made fun of	1.71	1.10	.762		.914
18. To avoid being rejected	1.81	1.19	.720		.917
70. To avoid hurting someone's feelings	1.68	1.09	.729		.916
71. To avoid conflict with others	1.73	1.14	.722		.917
72. To manage conflict with others	1.72	1.13	.736		.916
3. EOS – 7 items			**.810**	**.943**	
19. To counteract the effects of another drug	1.50	1.07	.893		.926
20. To reduce the effects of, or "come down" off of another drug	1.49	1.02	.789		.935
21. To enhance the effects of another drug	1.48	0.98	.799		.935
22. Because I am under the influence of another drug	1.40	0.87	.789		.936
23. To be able to use another drug for a longer period of time	1.47	1.02	.784		.936
24. To reduce the effects of another drug	1.47	1.01	.809		.934
25. To help with the side effects of a medication	1.44	0.97	.810		.934
4. RLR – 6 items			**.687**	**.879**	
26. Because it has fewer side effects than other drugs	1.85	1.31	.752		.847
27. Because it is not as bad for you as other drugs	1.95	1.32	.725		.852
28. Because it does not cause me as many problems as other drugs	1.83	1.29	.740		.849
29. Because I can handle the high better than with some other drugs	1.63	1.11	.577		.875
30. To get high / intoxicated with something I think is safer than other drugs	1.94	1.36	.706		.855
31. Because it is more socially acceptable than other drugs	2.05	1.36	.624		.870

Table 12 (continued).

5. PSI – 11 items			**.701**	**.926**	
32. To help me feel sociable or friendly	2.80	1.48	.741		.917
33. To make social gatherings and parties more fun	3.25	1.52	.553		.927
34. To lose my inhibitions in social situations	2.10	1.32	.625		.922
35. To feel more confident and sure of myself around others	2.59	1.52	.756		.916
37. To have a reason/excuse to socialize	2.38	1.32	.676		.920
39. To feel accepted by others	2.05	1.33	.671		.920
40. To make friends	2.36	1.35	.726		.918
41. To help me relate to others better	2.24	1.29	.724		.918
42. To have a sense of belonging to a social group	2.20	1.32	.716		.918
43. To communicate with others better	2.36	1.41	.770		.916
44. To feel more intimate with, connected to, or closer to others	2.29	1.37	.755		.917
6. REB – 6 items			**.700**	**.884**	
45. To break rules	1.66	1.13	.739		.857
46. To rebel against authority or society	1.64	1.12	.750		.855
47. To do something risky or dangerous	1.70	1.17	.721		.859
48. To do something illegal	1.40	0.92	.603		.878
49. To experience the thrill of doing something I’m not supposed to do	1.93	1.30	.683		.868
50. To do something socially unacceptable	1.62	1.10	.696		.864

Table 12 (continued).

7. APEP – 7 items		**.686**	**.887**	
51. To change my understanding of my perceptions (e.g., a spiritual awakening; special understanding of the universe; realizing the meaning in life)	1.65	1.02	.738	.865
52. To experience a blending of senses (e.g., tasting colors; seeing music as colors or patterns)	1.72	1.12	.714	.866
53. To alter how I perceive my environment (e.g., hear music in greater detail or complexity; enhance or dull sensations; drown out distractions)	1.94	1.26	.686	.870
54. To cause me to perceive things that are not present (i.e., to hallucinate; to see patterns or distortions that are not actually present)	1.51	1.03	.698	.869
55. To seek new experiences	2.35	1.37	.576	.886
56. To help me be more creative	1.96	1.23	.741	.862
57. To know what it's like to be under the influence of these substances	1.85	1.19	.646	.874
8. SUB – 3 items		**.768**	**.880**	
79. To get the same effects as something I'm prescribed when I run out of my prescription	1.56	1.09	.735	.860
80. To get the same amount of the drug I think I need when my doctor won't prescribe enough to me	1.50	1.08	.809	.792
81. To use a drug that is more powerful than one I have gotten used to	1.50	1.05	.761	.836

Abbreviations: MES, factor 1, Manage Emotional States; RAUA, Reduce Anxiety / Unpleasant Arousal; IPA, Increase Positive Affect; RNA, Reduce Negative Affect. MNSI-r, factor 2, Manage Negative Social Interactions-Revised; MNSI, Manage Negative Social Interactions; CNF, Conformity; EOS, factor 3, Effects of Other Substances; RLR, factor 4, Relative Low Risk; PSI, factor 5, Positive Social Interactions; REB, factor 6, Rebellion; APEP, factor 7, Altered Perceptions / Experiential Processes; SUB, factor 8, Substitution.

Table 13 *Means, Standard Deviations, Corrected Item-Total Correlations, and Alphas if Deleted for Marijuana-Only Group MUSQ*

	M	*SD*	*M* r_t	r_t	Cronbach's Alpha	Cronbach's Alpha if Deleted
1. MES (RAUA/IPA/RNA) – 20 items			**.728**		**.953**	
1. To calm down	3.57	1.64		.729		.950
2. To stop worrying	3.22	1.75		.791		.949
4. To release tension	3.75	1.64		.771		.949
5. To feel less on edge	3.32	1.73		.799		.949
6. To reduce feelings of anxiety or nervousness	3.48	1.74		.659		.951
7. To slow down racing thoughts	2.78	1.74		.727		.950
9. To feel less irritable	3.22	1.64		.774		.949
11. To decrease restlessness	3.10	1.71		.627		.951
58. To feel more joy or happiness	3.51	1.72		.770		.949
59. To help me get into a good mood	3.54	1.67		.754		.949
62. To feel more pleasure	3.47	1.67		.565		.952
63. To feel more excited	2.70	1.61		.484		.953
64. To feel content with life	3.01	1.63		.737		.950
65. To feel alive	2.38	1.57		.613		.951
66. To feel less bored	3.18	1.71		.547		.952
67. To feel euphoric or feel at peace	3.78	1.60		.605		.951
74. To reduce feelings of helplessness	2.44	1.72		.744		.950
75. To reduce feeling of hopelessness	2.48	1.66		.785		.949
77. To feel less lonely	2.19	1.49		.661		.951
78. To forget, escape, or avoid my memories	2.65	1.68		.672		.951

Table 13 (continued).

2. MNSI-r (MNSI+CNF) – 9 items			**.711**	**.915**	
13. To not be the only one not doing it	1.33	.880	.757		.902
14. To satisfy social pressure to use	1.38	.880	.768		.901
15. To be just like everybody else	1.39	.940	.743		.902
16. To follow what my friends are doing	1.41	.890	.747		.902
17. To avoid being made fun of	1.27	.870	.804		.899
18. To avoid being rejected	1.45	.940	.721		.904
70. To avoid hurting someone's feelings	1.41	1.02	.684		.906
71. To avoid conflict with others	1.54	1.03	.633		.910
72. To manage conflict with others	1.68	1.13	.540		.919
3. EOS – 7 items			**.679**	**.883**	
19. To counteract the effects of another drug	1.40	.850	.725		.860
20. To reduce the effects of, or "come down" off of another drug	1.53	1.00	.800		.848
21. To enhance the effects of another drug	1.69	1.08	.586		.878
22. Because I am under the influence of another drug	1.47	.950	.746		.856
23. To be able to use another drug for a longer period of time	1.34	.800	.647		.869
24. To reduce the effects of another drug	1.42	.900	.765		.854
25. To help with the side effects of a medication	1.52	1.04	.484		.891
4. RLR – 6 items			**.627**	**.845**	
26. Because it has fewer side effects than other drugs	2.79	1.80	.555		.834
27. Because it is not as bad for you as other drugs	2.84	1.83	.761		.791
28. Because it does not cause me as many problems as other drugs	2.49	1.81	.683		.808
29. Because I can handle the high better than with some other drugs	2.04	1.56	.615		.822
30. To get high / intoxicated with something I think is safer than other drugs	3.07	1.75	.564		.832
31. Because it is more socially acceptable than other drugs	2.14	1.54	.586		.827

Table 13 (continued).

5. PSI – 11 items			**.714**	**.929**	
32. To help me feel sociable or friendly	2.39	1.43	.719		.922
33. To make social gatherings and parties more fun	3.00	1.60	.590		.929
34. To lose my inhibitions in social situations	1.96	1.25	.721		.922
35. To feel more confident and sure of myself around others	2.04	1.43	.764		.920
37. To have a reason/excuse to socialize	1.98	1.34	.756		.920
39. To feel accepted by others	1.52	1.08	.643		.925
40. To make friends	1.77	1.15	.730		.922
41. To help me relate to others better	2.08	1.38	.800		.918
42. To have a sense of belonging to a social group	1.63	1.09	.703		.923
43. To communicate with others better	2.08	1.46	.761		.920
44. To feel more intimate with, connected to, or closer to others	2.33	1.40	.667		.924
6. REB – 6 items			**.677**	**.870**	
45. To break rules	1.33	.800	.682		.847
46. To rebel against authority or society	1.49	.940	.636		.855
47. To do something risky or dangerous	1.36	.910	.670		.848
48. To do something illegal	1.25	.720	.600		.860
49. To experience the thrill of doing something I’m not supposed to do	1.56	1.06	.702		.845
50. To do something socially unacceptable	1.35	.790	.770		.833

Table 13 (continued).

7. APEP – 7 items		**.534**	**.800**	
51. To change my understanding of my perceptions (e.g., a spiritual awakening; special understanding of the universe; realizing the meaning in life)	2.45	1.47	.548	.771
52. To experience a blending of senses (e.g., tasting colors; seeing music as colors or patterns)	2.26	1.48	.633	.755
53. To alter how I perceive my environment (e.g., hear music in greater detail or complexity; enhance or dull sensations; drown out distractions)	3.29	1.70	.575	.767
54. To cause me to perceive things that are not present (i.e., to hallucinate; to see patterns or distortions that are not actually present)	1.68	1.21	.518	.779
55. To seek new experiences	2.73	1.58	.603	.760
56. To help me be more creative	2.63	1.54	.430	.793
57. To know what it's like to be under the influence of these substances	1.96	1.37	.430	.792
8. SUB – 3 items		**.563**	**.734**	
79. To get the same effects as something I'm prescribed when I run out of my prescription	1.41	1.01	.502	.727
80. To get the same amount of the drug I think I need when my doctor won't prescribe enough to me	1.36	.900	.643	.547
81. To use a drug that is more powerful than one I have gotten used to	1.34	.850	.543	.668

Abbreviations: MES, factor 1, Manage Emotional States; RAUA, Reduce Anxiety / Unpleasant Arousal; IPA, Increase Positive Affect; RNA, Reduce Negative Affect. MNSI-r, factor 2, Manage Negative Social Interactions-Revised; MNSI, Manage Negative Social Interactions; CNF, Conformity; EOS, factor 3, Effects of Other Substances; RLR, factor 4, Relative Low Risk; PSI, factor 5, Positive Social Interactions; REB, factor 6, Rebellion; APEP, factor 7, Altered Perceptions / Experiential Processes; SUB, factor 8, Substitution.

Table 14 *Means, Standard Deviations, Corrected Item-Total Correlations, and Alphas if Deleted for SAM Group MUSQ*

	M	*SD*	*M* r_t	r_t	Cronbach's Alpha	Cronbach's Alpha if Deleted
1. MES (RAUA/IPA/RNA) – 20 items			**.661**		**.945**	
1. To calm down	3.29	1.41		.644		.943
2. To stop worrying	3.07	1.43		.694		.942
4. To release tension	3.62	1.37		.673		.943
5. To feel less on edge	3.21	1.42		.677		.942
6. To reduce feelings of anxiety or nervousness	3.39	1.46		.688		.942
7. To slow down racing thoughts	2.87	1.49		.587		.944
9. To feel less irritable	3.08	1.44		.708		.942
11. To decrease restlessness	2.88	1.45		.588		.944
58. To feel more joy or happiness	3.58	1.48		.704		.942
59. To help me get into a good mood	3.60	1.34		.711		.942
62. To feel more pleasure	3.69	1.31		.560		.944
63. To feel more excited	3.12	1.43		.611		.944
64. To feel content with life	3.11	1.50		.743		.941
65. To feel alive	2.86	1.55		.670		.943
66. To feel less bored	3.42	1.44		.569		.944
67. To feel euphoric or feel at peace	3.71	1.39		.577		.944
74. To reduce feelings of helplessness	2.68	1.58		.720		.942
75. To reduce feeling of hopelessness	2.74	1.56		.734		.941
77. To feel less lonely	2.71	1.47		.682		.942
78. To forget, escape, or avoid my memories	2.82	1.53		.687		.942

Table 14 (continued).

2. MNSI-r (MNSI+CNF) – 9 items			**.791**	**.947**	
13. To not be the only one not doing it	1.91	1.30	.786		.941
14. To satisfy social pressure to use	1.97	1.38	.827		.938
15. To be just like everybody else	1.97	1.34	.849		.937
16. To follow what my friends are doing	2.05	1.30	.775		.941
17. To avoid being made fun of	1.80	1.25	.824		.939
18. To avoid being rejected	2.01	1.35	.799		.940
70. To avoid hurting someone's feelings	1.94	1.31	.774		.941
71. To avoid conflict with others	2.17	1.41	.741		.943
72. To manage conflict with others	2.12	1.32	.745		.943
3. EOS – 7 items			**.719**	**.904**	
19. To counteract the effects of another drug	1.89	1.25	.830		.878
20. To reduce the effects of, or "come down" off of another drug	2.08	1.30	.724		.889
21. To enhance the effects of another drug	2.38	1.39	.591		.905
22. Because I am under the influence of another drug	2.09	1.34	.737		.888
23. To be able to use another drug for a longer period of time	1.90	1.25	.744		.887
24. To reduce the effects of another drug	1.85	1.24	.792		.882
25. To help with the side effects of a medication	1.82	1.27	.614		.901
4. RLR – 6 items			**.668**	**.869**	
26. Because it has fewer side effects than other drugs	2.61	1.58	.729		.836
27. Because it is not as bad for you as other drugs	2.67	1.60	.724		.837
28. Because it does not cause me as many problems as other drugs	2.66	1.61	.747		.832
29. Because I can handle the high better than with some other drugs	2.39	1.52	.634		.853
30. To get high / intoxicated with something I think is safer than other drugs	2.82	1.56	.625		.854
31. Because it is more socially acceptable than other drugs	2.41	1.49	.546		.867

Table 14 (continued).

5. PSI – 11 items			**.677**	**.917**	
32. To help me feel sociable or friendly	3.04	1.41	.688		.909
33. To make social gatherings and parties more fun	3.61	1.41	.486		.919
34. To lose my inhibitions in social situations	2.49	1.35	.590		.914
35. To feel more confident and sure of myself around others	2.76	1.50	.722		.908
37. To have a reason/excuse to socialize	2.54	1.38	.659		.911
39. To feel accepted by others	2.05	1.38	.713		.908
40. To make friends	2.44	1.40	.765		.906
41. To help me relate to others better	2.49	1.41	.734		.907
42. To have a sense of belonging to a social group	2.20	1.36	.709		.908
43. To communicate with others better	2.47	1.38	.668		.910
44. To feel more intimate with, connected to, or closer to others	2.82	1.41	.714		.908
6. REB – 6 items			**.768**	**.917**	
45. To break rules	1.91	1.29	.781		.900
46. To rebel against authority or society	1.88	1.27	.731		.907
47. To do something risky or dangerous	1.92	1.23	.781		.901
48. To do something illegal	1.72	1.21	.783		.900
49. To experience the thrill of doing something I’m not supposed to do	2.06	1.42	.740		.908
50. To do something socially unacceptable	1.77	1.21	.793		.899

Table 14 (continued).

7. APEP – 7 items		**.558**	**.818**	
51. To change my understanding of my perceptions (e.g., a spiritual awakening; special understanding of the universe; realizing the meaning in life)	2.59	1.37	.614	.784
52. To experience a blending of senses (e.g., tasting colors; seeing music as colors or patterns)	2.40	1.44	.632	.780
53. To alter how I perceive my environment (e.g., hear music in greater detail or complexity; enhance or dull sensations; drown out distractions)	3.39	1.45	.465	.809
54. To cause me to perceive things that are not present (i.e., to hallucinate; to see patterns or distortions that are not actually present)	2.06	1.34	.571	.791
55. To seek new experiences	2.85	1.45	.526	.799
56. To help me be more creative	2.74	1.33	.508	.801
57. To know what it's like to be under the influence of these substances	2.32	1.44	.589	.788
8. SUB – 3 items		**.693**	**.832**	
79. To get the same effects as something I'm prescribed when I run out of my prescription	1.81	1.23	.724	.735
80. To get the same amount of the drug I think I need when my doctor won't prescribe enough to me	1.70	1.17	.695	.766
81. To use a drug that is more powerful than one I have gotten used to	1.92	1.28	.660	.802

Abbreviations: MES, factor 1, Manage Emotional States; RAUA, Reduce Anxiety / Unpleasant Arousal; IPA, Increase Positive Affect; RNA, Reduce Negative Affect. MNSI-r, factor 2, Manage Negative Social Interactions-Revised; MNSI, Manage Negative Social Interactions; CNF, Conformity; EOS, factor 3, Effects of Other Substances; RLR, factor 4, Relative Low Risk; PSI, factor 5, Positive Social Interactions; REB, factor 6, Rebellion; APEP, factor 7, Altered Perceptions / Experiential Processes; SUB, factor 8, Substitution.

Hypothesis 4: Measurement Invariance of the MUSQ Across Substance Groups

Configural Invariance

For the multiple group configural model (Model 1), we constrained factor patterns (i.e., lower-order and high-order factor patterns) to be equal across groups. The configural model demonstrated acceptable fit (CFI = .935; RMSEA = .060), $\chi 2$ (*df* = 4538) = 11400.060, $p < .001$, suggesting the factor structure of the MUSQ was invariant across alcohol-only and SAM users (Table 15).

Metric Invariance

For the multiple group metric models, we constrained lower-order factor loadings and higher-order factor loadings to be equal across groups in two separate models. The metric higher-order model latent variable covariance matrices were non-positive definite. Examination of the output revealed statistically non-significant negative residual factor variance for Factor 2 (MNSI-r) in the ALC group and Factor 7 (APEP) in the SAM group, suggesting the residual variances for these factors was not statistically different than zero. Thus, the metric models were re-examined with the residual variances of Factor 2 and Factor 7 fixed to zero.

For the lower-order metric model (Model 2), the fit was acceptable (CFI = .944; RMSEA = .056), $\chi 2$ (*df* = 4601) = 10555.471 $p < .001$. Compared to Model 1, Model 2 demonstrated slightly better fit than that of Model 1 (ΔCFI = .009; ΔRMSRA = -.004). For the higher-order metric model (Model 3), the fit was acceptable (CFI = .935; RMSEA = .060), $\chi 2$ (*df* = 4909) = 11503.223, $p < .001$. Compared to Model 2, Model 3 demonstrated slightly worsened fit than Model 2 (ΔCFI = -.009; ΔRMSRA = .004); however, this finding did not change the fit to a statistically notable degree and did not

alter the fit compared to the configural model. Therefore, metric invariance for both the lower- and higher-order factor models across groups was demonstrated, suggesting the latent factor loadings were invariant across alcohol-only and SAM users (Table 15).

Scalar Invariance

For the multiple group scalar model (Model 4), we constrained lower- and higher-order factor loadings, and item thresholds, to be equal across groups. The scalar model demonstrated acceptable fit (CFI = .924; RMSEA = .063), $\chi 2$ (df = 4954) = 13078.333, p < .001; however, Model 4 showed a slight decrease in fit compared to Model 3, as evidenced by a decrease in CFI greater than .01 (ΔCFI = -.011; ΔRMSEA = .003). Thus, scalar invariance across the groups was not exhibited (Table 15).

Partial Invariance

Due to the lack of scalar invariance, we evaluated the potential for partial invariance at the scalar level. Modification indices (MIs) for threshold constraints in Model 4 revealed the MIs for the first and second thresholds for Item 21 (i.e., To enhance the effects of another drug); first threshold for Item 22 (i.e., Because I am under the influence of another drug); first and second thresholds for Item 51(i.e., To change my understanding of my perceptions [e.g., a spiritual awakening, special understanding of the universe, realizing the meaning in life]); first, second, and third thresholds for Item 53 (i.e., To alter how I perceive my environment [e.g., hear music in greater detail or complexity, enhance or dull sensations, drown out distractions]); and second and third thresholds for Item 67 (i.e., To feel euphoric or at peace) were of a notable and statistically significant size. Therefore, a partial invariance model (Model 5) was examined in which Model 4 was re-run with the constraints for the aforementioned

thresholds relaxed. The partial invariance model demonstrated acceptable fit (CFI = .926; RMSEA = .062), $\chi 2$ (df = 4944) = 12787.105, p < .001 and did not display a notable decrease in fit compared to the metric invariance model (Model 3; ΔCFI = -.009; ΔRMSEA = .002). As such, partial scalar invariance for the MUSQ was confirmed, with all thresholds demonstrating invariance except for two associated with EOS, two associated with APEP, and one associated with MES (Table 15). Model 5 indicated that thresholds 1 and 2 for Item 21 were .701 and 1.058 for the ALC group and -.319 and .171 for the SAM group. Threshold 1 for Item 22 was .767 for the ALC group and -.037 for the SAM group. Thresholds 1 and 2 for Item 51 were .327 and .877 for the ALC group and -.540 and -.075 for the SAM group. Thresholds 1, 2, and 3 for Item 53 were .072, .581, and 1.150 for the ALC group and -1.061, -.664, and .065 for the SAM group. Finally, thresholds 2 and 3 for Item 67 were .036 and .729 for the ALC group and -.913 and -.228 for the SAM group. Unstandardized factor loadings for Model 5 are presented in Table 16.

Table 15 *Invariance Fit Statistics for Alcohol-Only and SAM Users' MUSQ Responses*

	Fit Indices							
Model	*χ2*	*df*	*p*	RMSEA	CFI	Model Comparison	ΔRMSEA	ΔCFI
Baseline								
ALC	5372.742	2582	<.001	.048	.955			
SAM	5617.937	2582	<.001	.056	.940			
Model 1								
Configural	11400.060	4538	<.001	.060	.935			
Model 2						2 vs 1		
Metric – LO	10555.471	4601	<.001	.056	.944		-.004	.009
Model 3						3 vs. 2		
Metric – HO	11503.223	4609	<.001	.060	.935		.004	-.009
Model 4						4 vs 3		
Scalar	13078.333	4954	<.001	.063	.924		.003	-.011
Model 5						5 vs 3		
Partial	12787.105	4944	<.001	.062	.926		.002	-.009

Note: χ2, chi-square value; df, degrees of freedom; RMSEA, root mean square error of approximation; CFI, comparative fit index.

Abbreviations: ALC, alcohol-only users; SAM, simultaneous alcohol and marijuana user; LO, Lower-order latent factor loadings constrained; HO, Higher-order latent factor constrained.

Table 16 *Unstandardized Factor Loadings for Model 5 of the MUSQ*

	Lower-Order Factor								Higher
Items on Lower-Order Factors	MES	MNSI -r	EOS	RLR	PSI	REB	APEP	SUB	-Order Factor
MES									
1. To calm down	1.00								
2. To stop worrying	1.05								
4. To release tension	.967								
5. To feel less on edge	.988								
6. To reduce feelings of anxiety or nervousness	1.03								
7. To slow down racing thoughts	1.04								
9. To feel less irritable	1.11								
11. To decrease restlessness	1.07								
58. To feel more joy or happiness	1.05								
59. To help me get into a good mood	1.03								
62. To feel more pleasure	.955								
63. To feel more excited	1.07								
64. To feel content with life	1.17								
65. To feel alive	1.12								
66. To feel less bored	.976								
67. To feel euphoric or feel at peace	.997								
74. To reduce feelings of helplessness	1.21								
75. To reduce feeling of hopelessness	1.22								
77. To feel less lonely	1.22								
78. To forget, escape, or avoid my memories	1.14								
MNSI-r									
13. To not be the only one not doing it		1.00							
14. To satisfy social pressure to use		1.05							
15. To be just like everybody else		1.04							
16. To follow what my friends are doing		.946							
17. To avoid being made fun of		1.05							

Table 16 (continued).

18. To avoid being rejected	1.03			
70. To avoid hurting someone's feelings	1.02			
71. To avoid conflict with others	.998			
72. To manage conflict with others	1.01			
EOS				
19. To counteract the effects of another drug		1.00		
20. To reduce the effects of, or "come down" off of another drug		.934		
21. To enhance the effects of another drug		.896		
22. Because I am under the influence of another drug		.933		
23. To be able to use another drug for a longer period of time		.981		
24. To reduce the effects of another drug		.987		
25. To help with the side effects of a medication		.967		
RLR				
26. Because it has fewer side effects than other drugs			1.00	
27. Because it is not as bad for you as other drugs			.942	
28. Because it does not cause me as many problems as other drugs			1.02	
29. Because I can handle the high better than with some other drugs			1.05	
30. To get high / intoxicated with something I think is safer than other drugs			.953	
31. Because it is more socially acceptable than other drugs			1.01	
PSI				
32. To help me feel sociable or friendly				1.00

Table 16 (continued).

33. To make social gatherings and parties more fun	.717		
34. To lose my inhibitions in social situations	1.01		
35. To feel more confident and sure of myself around others	1.14		
37. To have a reason/excuse to socialize	1.06		
39. To feel accepted by others	1.33		
40. To make friends	1.19		
41. To help me relate to others better	1.20		
42. To have a sense of belonging to a social group	1.23		
43. To communicate with others better	1.18		
44. To feel more intimate with, connected to, or closer to others	1.16		
REB			
45. To break rules		1.00	
46. To rebel against authority or society		.925	
47. To do something risky or dangerous		.947	
48. To do something illegal		.906	
49. To experience the thrill of doing something I'm not supposed to do		.964	
50. To do something socially unacceptable		1.01	
APEP			
51. To change my understanding of my perceptions (e.g., a spiritual awakening; special understanding of the universe; realizing the meaning in life)			1.00
52. To experience a blending of senses (e.g., tasting colors; seeing music as colors or patterns)			1.02

Table 16 (continued).

53. To alter how I perceive my environment (e.g., hear music in greater detail or complexity; enhance or dull sensations; drown out distractions)	.863	
54. To cause me to perceive things that are not present (i.e., to hallucinate; to see patterns or distortions that are not actually present)	1.10	
55. To seek new experiences	.893	
56. To help me be more creative	1.01	
57. To know what it's like to be under the influence of these substances	1.03	
SUB		
79. To get the same effects as something I'm prescribed when I run out of my prescription		1.00
80. To get the same amount of the drug I think I need when my doctor won't prescribe enough to me		1.04
81. To use a drug that is more powerful than one I have gotten used to		1.00

Table 16 (continued).

Lower-Order Factors on Higher-Order Factor	
1. MES	1.00
2. MNSI-r	1.49
3. EOS	1.50
4. RLR	1.24
5. PSI	1.12
6. REB	1.47
7. APEP	1.32
8. SUB	1.52

Abbreviations: MES, factor 1, Manage Emotional States; RAUA, Reduce Anxiety / Unpleasant Arousal; IPA, Increase Positive Affect; RNA, Reduce Negative Affect. MNSI-r, factor 2, Manage Negative Social Interactions-Revised; MNSI, Manage Negative Social Interactions; CNF, Conformity; EOS, factor 3, Effects of Other Substances; RLR, factor 4, Relative Low Risk; PSI, factor 5, Positive Social Interactions; REB, factor 6, Rebellion; APEP, factor 7, Altered Perceptions / Experiential Processes; SUB, factor 8, Substitution.

Hypothesis 5: Mean Differences in MUSQ Latent Factors

We attempted to compare group latent factor means by setting the latent factor variances to zero for the ALC group and allowing the same latent factors in the SAM comparison group to vary; however, the model was not identified at the lower-order level because of the newly identified higher-order factor. This was likely due to too many parameters being estimated. Additionally, with the higher-order factor in the model capturing a large portion of the variance (i.e., residual first-order variances were quite small), a comparison of the latent factor scores across groups likely would not be very informative. Therefore, we only compared the latent means across groups for the higher-order factor within the partially invariant scalar model. The higher-order factor mean for the SAM group was .530, $p < .001$, suggesting a .530 standard deviation higher mean in the SAM group compared to the ALC group (which was fixed to zero for the purpose of testing the group mean difference).

Given that the latent means comparison model likely would not be meaningful at the first-order level within the higher-order model (and also not statistically identified), we compared the group means for the observed factor-based subscale scores (defined by the mean item response score for each subscale). As such, we conducted eight *t*-tests with a Bonferroni-correction of $p < .006$ to examine mean differences in the factor-based subscale scores across ALC and SAM users. We examined Levene's Test to determine whether the assumption of homogeneity of variance was violated. If significant, we relied on the "Equal variances not assumed" output. Results of the *t*-tests are presented in Table 17. As can be seen in Table 17, SAM users demonstrated statistically significant higher means than ALC users on all MUSQ latent factors except MNSI-r. Specifically, SAM

users scored between .21 (PSI) to .77 (APEP) units higher on the majority of MUSQ scales than ALC users, suggesting higher frequency of use for most motives.

Table 17 *Multiple Regression Analyses for MUSQ Scale Scores Predicting Use-Related Problems*

Factor	**ALC**			**SAM**				
	n	*M*	*SD*	*n*	*M*	*SD*	*t*	*p*
MES	418	2.43	1.034	354	3.17	1.018	-10.05	<.001*
MNSI-r	441	1.82	.921	358	1.99	1.114	-2.37	.016
EOS	440	1.46	.858	361	2.00	1.031	-7.85	<.001*
RLR	446	1.88	1.023	365	2.59	1.214	-8.99	<.001*
PSI	436	2.42	1.051	356	2.63	1.036	-2.79	.005*
REB	447	1.66	0.897	365	1.88	1.072	-3.08	.002*
APEP	446	1.85	.911	359	2.62	.971	-11.49	<.001*
SUB	454	1.52	.961	367	1.81	1.062	-4.09	<.001*

Note: * Significant with Bonferroni correction of p < .006.

Abbreviations: ALC, alcohol-only users; SAM, simultaneous alcohol and marijuana users; MES, factor 1, Manage Emotional States; RAUA, Reduce Anxiety / Unpleasant Arousal; IPA, Increase Positive Affect; RNA, Reduce Negative Affect. MNSI-r, factor 2, Manage Negative Social Interactions-Revised; MNSI, Manage Negative Social Interactions; CNF, Conformity; EOS, factor 3, Effects of Other Substances; RLR, factor 4, Relative Low Risk; PSI, factor 5, Positive Social Interactions; REB, factor 6, Rebellion; APEP, factor 7, Altered Perceptions / Experiential Processes; SUB, factor 8, Substitution.

Hypothesis 6: MUSQ Motives Predicting Use-Related Problems

We conducted four multiple regressions with MUSQ scale scores as independent variables and corresponding use-related problem variables (i.e., RAPI or MPI) serving as the dependent variable. Sample sizes ranged from 144 to 340. Results of these regression analyses are presented in Table 18. As seen in Table 18, all models were statistically significant and accounted for 30.1 to 52.5 percent of the variance in use-related problems. At the individual variable level, Manage Emotional States (MES) was a significant positive predicting variable of use-related problems across all models, such that as individuals' frequency of using alcohol, marijuana, or SAM for managing emotional states and experiences (e.g., to calm down, to feel more joy or happiness, or to feel less

lonely) increased by one unit, use-related problem scores increased by 3.074 (RAPI; Model 1); 2.810 (MPI; Model 2); and 2.177 (RAPI; Model 3) and 2.275 (MPI; Model 4), respectively. MES was the only significant predictor of use-related problems for SAM users (Model 3 and Model 4).

For Model 1 and Model 2, Effects of Other Substances (EOS) was a significant positive predictor of use-related problems for alcohol-only and marijuana-only users. As individuals' frequency of using alcohol-only and marijuana-only for managing the effects of other substances (e.g., to counteract or enhance the effects of another substance) increased by one unit, use-related problem scores increased by 5.563 (RAPI; Model 1) and 5.763 (MPI; Model 2), respectively.

Contrary to hypotheses, Altered Perceptions/Experiential Processes (APEP) was also a significant positive predictor of use-related problems among alcohol-only users (Model 1). A one-unit increase in frequency of using alcohol to alter one's perceptions or to seek new experiences (APEP) predicted a 3.713-unit increase in use-related problem scores (RAPI).

Table 18 *Multiple Regression Analyses for MUSQ Scale Scores Predicting Use-Related Problems*

	n	R^2	*B*	*SE B*	β	*t*	*p*
Model 1 (ALC - RAPI)	**340**	**.525**					**<.001***
(constant)			-9.373	1.119		-8.379	<.001*
MES (Factor 1)			3.074	.686	.293	4.484	<.001*
MNSI-r (Factor 2)			1.514	.933	.125	1.624	.105
EOS (Factor 3)			5.563	1.376	.411	4.044	<.001*
RLR (Factor 4)			-1.223	.668	-.113	-1.83	.068
PSI (Factor 5)			-.898	.647	-.088	-1.388	.166
REB (Factor 6)			.328	.806	.026	.407	.684
APEP (Factor 7)			3.713	.923	.299	4.023	<.001*
SUB (Factor 8)			-1.991	1.293	-.157	-1.54	.124

Table 18 (continued).

Model 2 (MARIJ - MPI)	**144**	**.365**					**<.001***
(constant)			-7.178	2.558		-2.807	.006*
MES (Factor 1)			2.810	.792	.308	3.546	.001*
MNSI-r (Factor 2)			.575	1.84	.038	.312	.755
EOS (Factor 3)			5.763	1.721	.369	3.348	.001*
RLR (Factor 4)			.095	.760	.011	.125	.901
PSI (Factor 5)			1.514	1.236	.141	1.225	.223
REB (Factor 6)			.653	1.928	.039	.338	.736
APEP (Factor 7)			-.977	1.035	-.089	-.944	.347
SUB (Factor 8)			-1.752	1.911	-.113	-.917	.361
Model 3 (SAM - RAPI)	**290**	**.350**					**<.001***
(constant)			-3.874	2.108		-1.837	.067
MES (Factor 1)			2.177	.856	.177	2.543	.012*
MNSI-r (Factor 2)			2.845	1.209	.245	2.354	.019
EOS (Factor 3)			.913	1.216	.071	.751	.454
RLR (Factor 4)			.089	.658	.009	.135	.893
PSI (Factor 5)			.672	1.099	.056	.611	.541
REB (Factor 6)			.236	1.013	.019	.233	.816
APEP (Factor 7)			-1.416	1.045	-.109	-1.355	.176
SUB (Factor 8)			2.685	1.165	.212	2.304	.022
Model 4 (SAM - MPI)	**286**	**.301**					**<.001***
(constant)			-3.564	2.186		-1.63	.104
MES (Factor 1)			2.275	.883	.187	2.577	.010*
MNSI-r (Factor 2)			.675	1.236	.059	.546	.586
EOS (Factor 3)			2.402	1.258	.190	1.909	.057
RLR (Factor 4)			.951	.688	.093	1.382	.168
PSI (Factor 5)			.309	1.145	.026	.270	.787
REB (Factor 6)			-.228	1.042	-.019	-.218	.827
APEP (Factor 7)			-.015	1.075	-.001	-.014	.989
SUB (Factor 8)			1.634	1.181	.132	1.383	.168

Note: * Significant with Bonferroni correction of $p < .01$.

Abbreviations: ALC, alcohol-only users; MARIJ, marijuana-only and concurrent users; SAM, simultaneous alcohol and marijuana users; RAPI, Rutgers Alcohol Problem Index; MPI, Marijuana Problem Index. MES, factor 1, Manage Emotional States; RAUA, Reduce Anxiety / Unpleasant Arousal; IPA, Increase Positive Affect; RNA, Reduce Negative Affect. MNSI-r, factor 2, Manage Negative Social Interactions-Revised; MNSI, Manage Negative Social Interactions; CNF, Conformity; EOS, factor 3, Effects of Other Substances; RLR, factor 4, Relative Low Risk; PSI, factor 5, Positive Social Interactions; REB, factor 6, Rebellion; APEP, factor 7, Altered Perceptions / Experiential Processes; SUB, factor 8, Substitution.

CHAPTER IV – DISCUSSION

Given the prevalence of alcohol and marijuana use, as well as the compounding adverse consequences of use-related problems as a result of simultaneous intoxication, the present study sought to further investigate the nature of motives for, and consequences of, using these substances. As hypothesized, higher frequency of alcohol-only, marijuana-only, and simultaneous alcohol and marijuana (SAM) use predicted more respective use-related problems. More frequent SAM use predicted greater marijuana use-related problems than marijuana-only use; however, increased frequency of alcohol-only use predicted greater alcohol use-related problems than that for more frequent SAM use. This finding runs contrary to previous research that has suggested greater likelihood of alcohol-related problems such as alcohol dependence (Midanik, Tam, & Weisner, 2007) and intoxicated driving (Terry-McElrath, O'Malley, & Johnston, 2013) for SAM users compared to alcohol-only users from the 2000 National Alcohol Survey and a sample of high school seniors, respectively. Thus, differences here may be attributed to a respectively narrower and adult sample.

To examine the nature of motives for using these substances, the present study also sought to investigate the psychometric properties of the Motivations for Using Substances Questionnaire (MUSQ) for alcohol, marijuana, and SAM users. Specifically, we (a) further evaluated the factor structure of MUSQ scores individually with alcohol and SAM users separately, (b) tested the measurement invariance of the MUSQ across alcohol and SAM groups, and (c) evaluated multiple indices of internal consistency of the MUSQ factor-based subscale scores, including item-total correlations and Cronbach's alpha.

CFA Baseline Models

Prior to invariance testing, individual group CFAs were conducted to establish the baseline model with acceptable fit in both groups individually. The previously-established 12-factor model derived from exploratory factor analysis (EFA) in the MUSQ pilot study (Altenberger, 2018) was reduced to three hypothesized models at the outset: One 11-factor model that removed the Performance/Arousal Enhancement factor items (which are inherently related to stimulant use) and separated a double-barreled Manage Negative Social Interactions (MNSI) item to increase the number of items for the factor from two to three; and two 10-factor models that allowed the three items from the MNSI factor to load with Conformity (CNF) and Positive Social Interactions (PSI) content, respectively. Ultimately, an 8-factor model was established as the baseline model due to best fit compared to alternative models and through examination of modification indices. The baseline model removed 11 items that cross-loaded on multiple latent factors and included a higher-order motivation factor; MNSI and CNF items combined into one latent factor (broadly managing negative social interactions, as hypothesized; MNSI-r); and combined Reduce Anxiety/Unpleasant Arousal (RAUA), Increase Positive Affect (IPA), and Reduce Negative Affect (RNA) items into one latent factor (broadly managing emotional states; MES). The more parsimonious baseline model demonstrated acceptable fit based on CFI and RMSEA for the SAM group and acceptable and excellent fit based on CFI and RMSEA, respectively, for the ALC group. Cronbach's alpha reliabilities for the subsequent factor-based subscales for the individual groups and total sample were in the good to excellent range and item-scale correlations were well above the minimum acceptable value.

Measurement Invariance Testing

Multiple groups CFA was used to test the measurement invariance of the MUSQ in a community and university sample of adults who reported past-month use. As expected based on prior research (e.g., Meda et al., 2017), the sample distribution was predominantly represented by alcohol users (45.6 percent; n = 461), followed by simultaneous alcohol and marijuana users (SAM; 37.0 percent; n = 374), which resulted in an underpowered sub-sample of marijuana-only users for tests of measurement invariance (17.3 percent; n = 175) despite efforts to capture a larger sample by including those who use both marijuana and alcohol, but not at the same time, in soliciting responses for marijuana-only motives on the MUSQ. As such, invariance testing was performed with two groups – alcohol-only (ALC) and SAM users.

Configural and metric invariance were observed for the MUSQ across ALC and SAM groups, suggesting the number of factors and factor loadings were psychometrically equivalent for these users. While full scalar invariance was not observed, partial invariance at the scalar level demonstrated acceptable fit with the only non-invariant parameters being thresholds 1 and 2 for Item 21; threshold 1 for Item 22; thresholds 1 and 2 for Item 51; thresholds 1, 2, and 3 for Item 53; and thresholds 2 and 3 for Item 67. Given that there are five thresholds per item (i.e., 350 total thresholds), non-invariance for ten thresholds (2.9 percent) across all items; three thresholds (8.6 percent) for EOS items; five thresholds (14 percent) for APEP items; and two thresholds (2.0 percent) for MES items can likely be regarded as inconsequential for the measurement of both the first-order and second-order factors of the MUSQ. As such, although technically only

partial scalar invariance was achieved, scores from the MUSQ can be considered scalar invariant across ALC and SAM groups for most practical purposes.

Inspection of the thresholds that did differ across groups indicated that, for a minority of item thresholds, a higher difficulty (or severity) level for the items was observed for the ALC group compared to that for the SAM group. Said differently, a higher level of the latent factor variable for an ALC user is required to endorse, for example, a '3" on Item 67 than is required for a SAM user. This difference in thresholds for EOS, APEP, and MES items may reflect inherent differences in the psychotropic effects of the substances (e.g., the greater likelihood of hallucinating via marijuana versus alcohol intoxication) or possibly statistical artifacts due to low endorsement of these motives at these frequencies.

MUSQ Mean Difference Testing across Groups

Because the MUSQ demonstrated invariance across levels of sequentially greater numbers of group invariance constraints, the results suggest the MUSQ is a psychometrically appropriate measure to not only assess, but also make meaningful comparisons across alcohol and SAM users' motivations for using these substances. Thus, differences in latent factor scores between alcohol and SAM users can be understood as legitimate and meaningful, and not due to measurement bias or error. As such, we investigated mean differences on motives between alcohol and SAM users. The results in our sample indicated that, at both the lower- and higher-order levels and with the exception of MNSI-r at the lower-order level, SAM users tended to simultaneously use alcohol and marijuana more frequently for all motives compared to how often the

ALC group used alcohol by itself for the same reasons. SAM and alcohol-only users did not differ in their frequency of use for MNSI-r reasons.

MUSQ Motives Predicting Use-Related Problems

Finally, we evaluated the construct validity of the MUSQ by examining the MUSQ's factor scales' abilities to predict use-related problems. Although the baseline model of the MUSQ for this study captured a factor in which content from the three broad emotion management factors (RAUA, IPA, and RNA) loaded onto one latent variable (i.e., Manage Emotional States; MES), this nevertheless supported our hypothesis that these emotion regulation/coping motives would predict greater use-related problems regardless of which substance group was referenced in MUSQ responses. For alcohol- and marijuana-only users, Effects of Other Substances (EOS) was also a significant predictor of use-related problems. Compared to a lack of predictive power of EOS for SAM users' use-related problems, this factor may have been more salient for problems within the alcohol-only and marijuana-only groups due to the nature of the construct. SAM use may inherently occur as a means to manage effects of marijuana or alcohol and, therefore, does not contribute to the prediction of problems, whereas more frequent alcohol or marijuana use to manage the effects of other substances (e.g., cocaine or benzodiazepines) may be associated with more use-related problems. Contrary to hypotheses, Altered Perceptions/Experiential Processes (APEP) was also a significant positive predictor of use-related problems among alcohol-only users. This may be because those pursuing altered perceptions through alcohol use are necessarily using greater amounts to achieve this. Manage Negative Social Interactions – Revised (MNSI-r; combining Conformity [CNF] and Manage Negative Social Interactions

[MNSI] content) and Positive Social Interactions (PSI) did not account for use-related problems at the individual variable level. Findings with respect to the relationship between social motives and problems have been mixed – more frequent use of alcohol and marijuana for conformity and social acceptance motives has been correlated with less frequent and lower quantities of consumption for alcohol and marijuana use (e.g., Novacek, Raskin, & Hogan, 1991; Grant et al., 2007), whereas more frequent use of alcohol and marijuana for positive social motives has predicted higher drinking frequency and quantity (Grant et al., 2007) as well as higher frequency of marijuana use-related problems (Simons, Correia, Carey, & Borsari, 1998), respectively. Not surprisingly, these motives did not appear salient to the prediction of problems in our sample.

Strengths and Implications of the Current Study

This study expanded the limited, but growing, current literature on the effects and predictors of simultaneous alcohol and marijuana use. To our knowledge, only one study has investigated motives for alcohol, marijuana, and SAM use, which was limited to conformity, calming/anxiety/arousal reduction (i.e., Calm/Coping), enhancing positive effects of other substances (i.e., Positive Effects [similar to the MUSQ's EOS]), and enhancing social experiences SAM motives (i.e., Social [similar to the MUSQ's PSI]; Patrick, Fairlie, & Lee, 2018). The MUSQ allowed for a more comprehensive and appropriate assessment of SAM and alcohol motives by directly comparing motives in a unity measure as opposed to using separate assessment tools (i.e., the Drinking Motives Questionnaire – Revised, Grant, et al., 2007; and a measure developed for the aforementioned study). In addition to Patrick and colleague's four motives, the MUSQ captured using to increase positive affect states (e.g., euphoria) and to manage other

negative affective states (e.g., loneliness and hopelessness; MES), to substitute one substance for another (SUB), because of the relative low risk of using compared to using or doing something else (RLR), to rebel (REB), and to manage negative social interactions beyond conformity (MNSI-r). For alcohol and SAM users, the MUSQ demonstrated acceptable fit and good reliability, as well as aided in the prediction of use-related problems.

In addition, this study expanded the generalizability of findings compared to that of Patrick and colleague's research on motives for SAM use. Although most participants were considered young adults, our sample ranged from 18 to 71 years of age with an average participant age of 25 years. Our sample was also geographically more diverse, given that the online data collection allowed for participants across the United States. We collected data from both a university and community sample, which aided in the study's external validity.

The results of this study also reduced the total number of items for the MUSQ from 85 derived from the pilot EFA to 70 items that that demonstrated measurement invariance across alcohol and SAM users as well as good internal consistency reliability and evidence for construct validity. This reduction in items may serve to reduce response fatigue and allow for more time-effective assessment in investigating an individual's reasons for use as a target of intervention.

Limitations and Future Directions

Despite its strengths, the study was not without limitations. While efforts were made to increase the subsample of marijuana-only users, that size of that subsample did not yield adequate power to examine the invariance of the MUSQ for this group. More

adequate recruitment efforts may need to be made in future studies to capture this population, such as promotion of the research at bars, head shops, smoke shops, and dispensaries. It may also be beneficial to loosen the eligibility requirements from past-month use to past 6-month or past-year use; however, concerns regarding retrospective memory to reflect on such motives could increase.

Although our sample was arguably diverse to a degree, there were nevertheless limitations to the representativeness of our sample of alcohol, marijuana, and SAM users. Approximately 43 percent of the sample were undergraduate students. There were disproportionally more women in the alcohol group (69.4 percent) than men and those with other gender identities, as well as more men in the SAM group (53.4 percent) than women and other gender identities. Our data for use-related problems was also positively skewed across substance groups, suggesting a more diverse sample with a broader range of problem severity would be beneficial in future studies.

Participant's geographical location was not accounted for in this study, which may have been an important factor to consider when soliciting reasons for marijuana use, as states differ in their legality, cultural acceptability, and medicalization of use. Relatedly, numerous functional/self-medication motives (e.g., to sleep, to reduce pain, to alleviate medical conditions) were dropped from the initial item content in the MUSQ pilot study based upon results of an EFA; however, several participants contacted the researcher to note that they felt some of their motives for using marijuana, such as these, should have been included. In lieu of removing the Performance/Arousal factor item content for marijuana and SAM users' motive assessment (as irrelevant motives), it may be appropriate to re-examine the MUSQ's factor structure again with the inclusion of

functional and self-medication motive items. It may have been the case that there were not enough items within this content area to have yielded a reliable factor in the pilot study. Thus, it may be useful to write new items within this content area, and conduct a psychometric study including the original items that were dropped, combined with the new items.

Finally, for SAM users, we did not include a measure of SAM use-specific problems. Participants indicated the degree to which they experienced past-year alcohol-related and marijuana-related problems with the RAPI and MPI, respectively. Future studies may benefit from capturing SAM-specific problems in models of motives predicting consequences, such as the degree to which nausea/vomiting, unsafe sex, clumsiness in motor functioning, and difficulty concentrating has occurred as a result of SAM use.

Conclusion

The MUSQ is a psychometrically appropriate assessment tool to evaluate the reasons individuals use alcohol by itself and in combination with marijuana. This is the first study to directly compare frequency of use for motives in a unitary measure for alcohol and SAM users. The performance of the MUSQ should be tested in samples with greater variability in use-related problems, as well as with other substance-using groups with a particular emphasis in capturing motives for using marijuana by itself. Finally, content from the pilot study of the MUSQ related to using for pain and sleep management should be included and re-examined with greater attention to data collected from individuals in states with and without legal and medicinal privileges for using marijuana before completely removing such item content from the measure. It is hoped that

continued development and use of the MUSQ will lead to better assessment of motives for substance use and, ultimately, for such knowledge to aid in improving the effectiveness of both treatment and prevention of substance-related disorders.

APPENDIX A – IRB Approval Letter

IRB-20-405 - Initial: Sacco Committee Letter - Expedited and Full

irb@usm.edu <irb@usm.edu>
Wed 10/14/2020 8:33 AM

To: Randolph Arnau <Randolph.Arnau@usm.edu>; Taylor Altenberger <Taylor.Altenberger@usm.edu>; Sue Fayard <Sue.Fayard@usm.edu>; Michael Howell <Michael.Howell@usm.edu>; Jonathan Snyder <Jonathan.Snyder@usm.edu>

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NOTICE OF INSTITUTIONAL REVIEW BOARD ACTION

The project below has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services regulations (45 CFR Part 46), and University Policy to ensure:

- The risks to subjects are minimized and reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered involving risks to subjects must be reported immediately. Problems should be reported to ORI via the Incident template on Cayuse IRB.
- The period of approval is twelve months. An application for renewal must be submitted for projects exceeding twelve months.
- Face-to-Face data collection may not commence without prior approval from the Vice President for Research's Office.

PROTOCOL NUMBER: IRB-20-405
PROJECT TITLE: A Re-Examination of the Motivations for Using Substances Questionnaire: Motives for Alcohol, Marijuana, and Combined Use
SCHOOL/PROGRAM: School of Psychology, Psychology
RESEARCHER(S): Taylor Altenberger, Randolph Arnau

IRB COMMITTEE ACTION: Approved
CATEGORY: Expedited
7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

PERIOD OF APPROVAL: 2020-10-14

Donald Sacco Jr.

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