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# Cognitive Biases in Alcohol and Marijuana Users

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COGNITIVE BIAS IN MARIJUANA  
AND ALCOHOL USERS

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A Thesis  
Presented to  
The Graduate Faculty  
Central Washington University

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In Partial Fulfillment  
of the Requirements for the Degree  
Master of Science  
Experimental Psychology

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by  
Wyatt G. Frahm  
July 2017

CENTRAL WASHINGTON UNIVERSITY

Graduate Studies

We hereby approve the thesis of

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Candidate for the degree of Master of Science

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Dean of Graduate Studies

## ABSTRACT

### COGNITIVE BIAS IN MARIJUANA AND ALCOHOL USERS

by

Wyatt G. Frahm

July 2017

The current study investigated the influence of marijuana and alcohol consumption and craving on a primed word stem completion (WSC) task. One hundred participants were randomly assigned to one of three prime conditions: Substance-prime, neutral-prime, and no-prime. In the substance- and neutral-prime conditions, participants were presented with a series of prime words. After a distracter task those participants who were presented with a series of prime words, all participants were given a multi-solution WSC task, which consisted of the initial two to four letters of a word for which the participants were instructed to complete with the first word that came to mind. The numbers of substance-related and neutral-prime solutions that were produced by each participant were tallied to produce a score. Participants were then further instructed to complete measures of alcohol and marijuana consumption and craving and these measures were used as covariates in a MANCOVA analysis. The primes had a significant effect on performance in the WSC task, with the substance-prime increasing the number of alcohol- and marijuana-related word solutions compared to the neutral- and no-prime conditions. Alcohol consumption significantly influenced the production of alcohol-related word solutions, but neither marijuana consumption nor craving was associated with the production of marijuana-related

word solutions. These results demonstrate that both priming and past alcohol use significantly influenced performance on a WSC task, indicating the presence, at least in part, of a cognitive bias in those who use alcohol.

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CHAPTER I  
LITERATURE REVIEW

**Cognitive Bias in Marijuana and Alcohol Users**

Marijuana is the most commonly used federally illegal substance in America with 52.7% of young adults aged 18 to 25 reporting having used marijuana at least once in their life (Center for Behavioral Health Statistics and Quality, 2015). Although marijuana is currently federally illegal, there is a growing trend in many states towards legalization. This wave of state level legalization provides researchers with an opportunity to study the effects of marijuana on individuals. In the past, due to the illicit nature of the substance, it was difficult to gain approval to study the cognitive and behavioral effects of marijuana on the general population, resulting in a lack of research in the area. It is imperative that researchers gain a better understanding of the impact of marijuana use, as the rate of marijuana use shows no signs of decreasing.

Alcohol is responsible for 88,000 deaths annually in America. Alcohol is by far the most widely used controlled substance in America with 82.4% of adults aged 18 to 25 having consumed alcohol at least once in their lives and 58.3% having consumed alcohol in the last month (Center for Behavioral Health Statistics and Quality, 2015; Centers for Disease Control and Prevention, 2013). Alcohol is a dangerous and addictive substance with approximately 15.1 million adults in America alone suffering from alcohol addiction (Center for Behavioral Health Statistics and Quality, 2015). While there are therapies and treatments for alcoholism, ongoing research into the mechanisms of addiction is a necessity.

The effects of marijuana use on cognitive processes are not well understood. Specifically, potential cognitive biases in marijuana users have not been as thoroughly

investigated as cognitive biases for other substances, including alcohol and tobacco. Importantly, modifying those cognitive biases may result in improved recovery outcomes or addiction treatment strategies (Kakoschke, Kemps, & Tiggemann, 2017). One form of cognition biases is implicit memory bias that can be measured by word stem completion (WSC) tasks. Specifically, the manner in which a substance user completes an incomplete word could be indicative of different use patterns such as level of substance use, motivational differences, craving levels, or the existence of problem use profiles as suggested by research investigating other cognitive biases (Field & Cox, 2008; Field, Mogg, Zetteler, & Bradley, 2004; Lambe, Hudson, & Stewart, 2015). Thus, research utilizing WSC tasks to investigate cognitive biases could aid clinicians in identifying patients at-risk of addiction.

### **Cognitive Biases**

There are a host of factors involved in substance use and addictive behaviors and cognitive biases may be involved in their development and maintenance. Implicit cognitive biases for addiction-related stimuli have been found in tests such as the Stroop test, implicit association tests, and word association tests, indicating biases in attention, attitude, and semantic association (Rooke, Hine, & Thorsteinsson, 2008). These cognitive biases have been documented over a range of addictive substances and behaviors, including alcohol, marijuana, cigarettes, heroin, and gambling (Rooke et al., 2008). It has generally been found that those with problematic use patterns or heavier use patterns have positive biases towards their substance of choice (Rooke et al., 2008). For example, Litz, Payne, and Colletti (1987) found that smokers had better incidental recall for positive explicit memories related to smoking. Stacy, Ames, Sussman, and Dent (1996) found that heavier users of alcohol and marijuana tended to respond to ambiguous cue words with significantly more substance-

related associations. In that study, participants were asked to respond to a word cue with the first word that the cue word made them think of and those associations were then judged as either substance- or nonsubstance-related by researchers. These studies serve to demonstrate that substance-related memories appear to be more accessible in heavier substance users.

Attentional bias is a major topic of investigation in the area of cognitive biases and substance use and abuse. Most studies investigating attentional bias have found a significant effect of substance use on attentional bias towards substance-related cues (Cousijn et al., 2013; Cox, Hogan, Kristian, & Race, 2002; Field, Mogg, & Bradley, 2004; Schoenmakers, Wiers, & Field, 2008). Attentional bias is typically assessed through a Stroop interference task, in which participants must identify the color of the word presented while ignoring semantic word content (Stroop, 1935). When a participant is distracted by the semantic content, the result is a longer response time to identify the color of the word, revealing an attentional bias. Many studies have used Stroop tasks to investigate attentional biases in a variety of topics (Carpenter, Schreiber, Church, & McDowell, 2006; Cox, Fadardi, & Pothos, 2006; Fridrici et al., 2013). For example, Cousijn et al. (2013) investigated the impact of marijuana-related words on those with marijuana dependence and found that an attentional bias towards marijuana was significantly positively correlated with scores on the Cannabis Use Disorder Identification Test, a measure of marijuana use disorder. Townshend and Duka (2001) utilized a dot probe paradigm and found similar results in heavy social drinkers. The dot probe task assesses attentional bias by presenting two images and replacing one with a dot probe. Participants are instructed to respond to the dot as quickly as possible. Increased latency in responding to the dot probe is theorized to indicate that the focus of visual attention was on the other image. Townshend and Duka (2001) found that heavy social

drinkers had an attentional bias for alcohol-related stimuli when compared to occasional social drinkers.

### **Word Stem Completion (WSC) Task**

While research on implicit memory biases in substance users is limited, studies that have utilized WSC tasks have found that results mirrored those of other measure of cognitive bias (Kemps, Tiggemann, & Hollitt, 2014a; McCusker & Gettings, 1997). WSC tasks provide a measure of biased information processing that has not been utilized very often in the investigation of cognitive biases, even though the studies that have used it have found promising results. The WSC task was developed as a measure of implicit memory and originally was used to investigate memory in patients with amnesia. Implicit memory refers to memory systems that can be activated or accessed without the conscious awareness of the individual. Implicit memory contrasts with explicit memory that requires conscious retrieval (Schacter, 1992). The WSC task is a well-established measure of implicit memory. The measure is typically preceded by a priming task, such as a word list, which is often followed by a distracter task. Then, word stems, commonly consisting of three letters, are presented, and the participant is asked to complete those stems to form full words. Despite reporting having no explicit memory of the primed words, amnesic patients had similar performance to a control group (Graf & Mandler, 1984). Such findings provide evidence that WSC tasks are assessing memory or attentional systems separate from conscious awareness.

Few studies have utilized the WSC task as a measure of biased information processing even though results from WSC tasks are similar to measures of attentional bias (Kemps et al., 2014a; McCusker & Gettings, 1997). Kemps et al. (2014a) investigated attentional biases toward food cues in obese individuals by utilizing a dot probe paradigm

similar to that utilized by Townshend and Duka (2001), and found that obese and overweight women had response times slower than normal weight controls as well as faster response times for high calorie food words compared to animal words indicating an attentional bias for high calorie food words. Then, researchers attempted to modify this bias by training participants to attend to or avoid food cues. The training resulted in an increased bias for food cues in the attend condition and a decreased bias in the avoid condition during subsequent testing. Similar results of the training were observed in a WSC task in which those participants who had been in the attend condition produced significantly more food-related word stems than did participants in the avoid condition (Kemps et al., 2014).

McCusker and Gettings (1997) investigated attentional bias in gamblers with a Stroop task, then, a WSC task that was primed using the Stroop task. Gamblers differed significantly from their spouses and controls in response times on the Stroop task as well as for the number of gambling-related words completed on the WSC task (McCusker & Gettings, 1997). Importantly, based upon these findings it appears that measures of attentional bias, such as the dot probe task and Stroop task are measuring similar constructs to that of the WSC task.

Many factors affect how a person responds to a WSC task, including the frequency with which a person is exposed to a word. Shaw (1997) and Soler, Dasí, and Ruiz (2015) determined that the most influential factors in which words are produced in an unprimed WSC task is familiarity and word length. However, familiarity alone is not necessarily sufficient to produce specific responses. For example, McCusker and Gettings (1997) found that the spouses of gamblers produced significantly fewer gambling-related solutions after a prime compared to the gamblers themselves despite their spouses having been previously

exposed to gambling-related constructs. From the research to date, it is not clear if there is an effect of addiction or substance use on the production of addiction- or substance-related words that goes beyond the participants' familiarity with the word. However, McCusker and Gettings' (1997) findings suggest that more than just familiarity with the words and their related constructs underlies specific word responses on WSC tasks.

Priming participants before the presentation of a WSC task is a very common procedure. Such priming was originally established as a critical component of a WSC task because the WSC task's main goal was to assess participants' memory of primed words. It is well established that there is an effect of priming on WSC tasks and WSC tasks have been often used as a measure of implicit memory (Graf & Mandler, 1984; Graf, Shimamura, & Squire, 1985; Postle & Corkin, 1999; Soler et al., 2015) Most recently, Soler et al. (2015) assessed the influence of priming on WSC and word fragment completion tasks and found that priming had a significant impact on the words produced in both measures. McCusker and Gettings (1997) found that problem gamblers produced more gambling-related solutions to a WSC task than did controls or their spouses. This could indicate that addicts or those with heavy engagement in an addictive behavior may be more sensitive to priming of addiction-related stimuli. Given these findings, it is likely that heavy users of marijuana or alcohol will be more sensitive to primes related to those substances in the same way gamblers were more sensitive to gambling-related words. While it is likely that priming for marijuana- and alcohol-related words will result in more marijuana solutions being produced, it is unknown at what rate substance-using participants will produce substance-related words without priming and whether an individual's level of substance usage would modulate that effect.

It is also unclear to what effect priming for neutral words in comparison to no prime or a substance-related prime will have on performance among heavy substance users. A study investigating semantic priming utilizing a word fragment task found that priming participants with a semantically similar word to a possible solution of a word fragment made it more difficult to come up with an alternate word (Heyman, Hutchison, & Storms, 2016). For example, priming the participant with the word *push* for the word fragment *sh\_ve* made it more difficult to produce the solution *shave* due to interference from the word *shove*. In that study, researchers told the participants to solve the word fragment with any letter that would make a word with the exclusion of a prohibited letter.

The WSC task has thus far been underutilized as a measure of biased cognitive processing. While there are few studies that have investigated cognitive biases with a WSC task, those that have found that it is closely related to other more established measures of cognitive biases such as the Stroop interference task. Research has shown that cognitive biases are related to addictive behaviors, and, should the WSC task prove to be a reliable measure of cognitive bias, it would provide researchers and clinicians with an inexpensive and simple method to measure such biases.

### **Craving**

Substance craving is the desire to re-experience the effects of that substance. It is commonly associated with subjective urges to use the substance, obsessive thoughts and behaviors related to the substance or obtaining the substance, and/or the desire to relieve symptoms of withdrawal (Robinson & Berridge, 1993). Not all of these symptoms occur in all those craving a substance but craving is a major factor in a substance users continued use of the substance and relapse after quitting. The incentive sensitization model postulates that

substance-related stimuli can elicit classically conditioned responses (Robinson & Berridge, 1993) which may explain the observed attentional bias to substance-related stimuli in substance users and abusers. For example, Field et al. (2004) utilized a dot probe task and found that heavy social drinkers had an attentional bias for alcohol-related pictures compared to the response of light social drinkers. It has also been shown that attentional bias measured via the dot probe task as well as subjective craving increased after a small dose of alcohol in heavy drinkers (Schoenmakers et al., 2008).

There is conflicting evidence on the effect of craving on cognitive biases. Some researchers have found positive correlations between substance craving and cognitive biases while others have not been able to demonstrate such an effect. In a study on heroin-dependent participants, a correlation was observed between craving and reaction time on a Stroop interference test, indicating biased attentional processing for heroin-related cues (Franken, Kroon, Wiers, & Jansen, 2000). In contrast, Ehrman et al. (2002) investigated attentional bias with a visual dot probe task in cigarette smokers and did not find any correlation between craving and attentional bias. In another study, craving for alcohol was increased in heavy drinkers following administration of a small amount of alcohol, but no correlation was found between craving and attentional bias in those same participants (Schoenmakers et al., 2008). Metrik et al. (2016) found that cue-elicited changes in the subjective urge to use marijuana (i.e., craving) predicted attentional bias for marijuana-related words as measured by a Stroop task. Field et al. (2004) also found that craving for marijuana was associated with attentional bias as measured by a dot probe task, but not with implicit association as assessed by an implicit association test, which assessed positive or negative implicit associations with a marijuana stimulus. Overall, the research appears to be trending towards craving having an



influence on cognitive biases (Field & Cox, 2008) and, according to the incentive sensitization model, craving should have an influence on cognitive biases. Though the research is not conclusive, investigating the impact of craving on a WSC task could help clarify the relationship between cognitive biases and craving.

### **Motives**

Individuals often have specific motivation in their use of a substance and different motivations may produce different outcomes for users. Those who have endorsed coping motives for alcohol and marijuana consumption report a greater frequency of substance-related problems and abuse (Bonn-Miller, Zvolensky, & Bernstein, 2007; Cooper, 1994; Cooper, Russell, & George, 1988). Another study found that decreases in coping motivations for marijuana use were related with more successful treatment results (Banes, Stephens, Blevins, Walker, & Roffman, 2014). Coping motives are both related to an increase in substance-related problems and increased attentional bias. These results were reinforced by Lambe et al. (2015) as well as Stewart, Hall, Wilkie, and Birch (2002). Both of those research teams found that users that endorsed coping motives had greater distractibility than users with other primary motives for use, such as social and enhancement motives. Thus, substance use motives may influence the strength of attentional bias or implicit association effects.

### **Treatment Implications**

Given the current literature indicating an association between cognitive biases and substance abuse and dependence, several researchers have attempted to alter these biases, with varying results. Many studies have shown that modification of cognitive biases resulted in improved recovery outcomes (Kakoschke et al., 2017; Kemps et al., 2014a; Wiers, Eberl,

Rinck, Becker, & Lindenmeyer, 2011). In one such study, approach bias was targeted, and the researchers trained participants to implicitly avoid alcohol-related stimuli in two ways. The first way was in avoidance action with the explicit instruction of having the participants push away on a joy stick in response to an alcohol image cue. The second way was instructing participants to perform the same avoidance action in response to a specific orientation of the image cue, which was always the same as the alcohol image. This resulted in participants in the experimental conditions demonstrating a stronger avoidance bias than they did at pretest whereas the control groups maintained a similar approach bias. Although this finding was reported as a trend and was not statistically significant, the experimental groups had significantly decreased rates of relapse one year later when compared to those in the control condition (Wiers et al., 2011).

Other studies have demonstrated success in retraining responses to specific stimuli but with results that do not always generalize to other stimuli or other measures of cognitive biases. Schoenmakers, Wiers, Jones, Bruce, and Jansen (2007) found that they were able to retrain participants with an existing attentional bias for an image of an alcoholic beverage and, instead, induce a bias for an image of a soft drink. However, the retraining did not transfer to a novel stimuli and did not influence self-reported craving for alcohol. Retraining attentional biases for food stimuli has also been demonstrated in obese participants. As previously detailed, Kemps et al. (2014) found obese women had an attentional bias for food cues compared to women of normal weight but that the bias could be modified as assessed by a WSC task. The retraining of cognitive biases has shown promising results for addiction treatment. Though more research needs to be done, retraining cognitive biases could aid in the treatment of many types of addictive behaviors.

## **Hypotheses of the Current Research**

The purpose of the current study was to investigate the effects of priming for specific words on answers to a WSC task in marijuana and alcohol users, particularly when the priming involved marijuana- and alcohol-related terms. As well, this study was designed to determine if marijuana and alcohol use correlated with performance on a primed WSC task that included marijuana- and alcohol-related terms. While it was expected that the level of substance use would impact performance, it was also anticipated that substance craving at the time of testing would be associated with changes in performance. Specific hypotheses that were tested by this study included that: (a) the type of prime (Neutral, No-prime, Substance-related) would influence performance on a WSC task; (b) self-reported substance use would be associated with performance on a WSC task; and (c) higher self-reported substance craving would be associated with increased production of substance-related terms in the WSC task.

## CHAPTER II

### METHOD

#### **Participants**

Participants consisted of 38 males and 62 females from states that have legalized recreational marijuana. Participants were recruited through Qualtrics panels. The primary investigator paid Qualtrics \$23 for each participant. Qualtrics then compensated participants for their participation at a rate unknown to the primary investigator. Qualtrics panels is a data collection service provided through Qualtrics that allows people to participate in studies for a monetary reward. Participants were required to have English as their primary language. They also had to report having used both marijuana and alcohol at least once in their life. Due to legal age restrictions for alcohol and marijuana use, participant age was restricted to 21 and over. The mean age participants reported was  $44.1 \pm 13.1$  years of age. Institutional human subject use approval was obtained from Central Washington University's Human Subject Research Council.

Eleven participants reported having a prescription for medical marijuana while 89 did not. For education, one participant reported less than a college degree, 9 reported being a high school graduate, 33 had some college but no degree, 11 had an associate degree, 34 had a bachelor's degree, 8 had a master's degree, 2 had a doctoral degree, and 2 reported having a professional degree. The state of residence was primarily from California with 45 of the 100 participants residing in that state, 2 from Alaska, 8 from Colorado, 3 from Nevada, 2 from Maine, 15 from Massachusetts, 10 from Oregon, 12 from Washington, and 3 from Washington DC. Lastly, ethnicity was primarily reported as white/Caucasian by 90 of the

100 participants, 2 Black or African-American, 3 Asian, 1 American Indian and 4 of mixed race.

## **Materials**

**Primes.** Differences in the types of the primes constituted the independent variable, consisting of no-prime, a neutral prime condition, and a substance-related prime condition. The primes consisted of marijuana- and alcohol-related terms (e.g., liquor, smoke, and vodka) and neutral words with no affiliation to marijuana or alcohol (e.g., table, fresh, rock, happy). See Appendixes A through C. The substance-related prime condition consisted of the presentation of 17 alcohol-related word primes, 17 marijuana-related word primes, and 17 neutral non-substance word primes. The neutral prime condition consisted of the presentation of 51 non-substance word primes. Participants in the no-prime condition were not primed in order to establish a comparison rate of word completion. Immediately following the informed consent information, participants in the no-prime condition began the WSC task, in which they were presented with the word stems and, thus, those in the no-prime condition were not presented with either the primes or the distracter task.

The neutral prime words were matched on frequency and length with their substance-related word counterpart. This was done in an attempt to control for the length or frequency of the word. Frequency of the words was determined by Brysbaert and New's (2009) database on word frequencies in the United States, which were determined by sampling television and movie subtitles. The alcohol-related words selected for the current study had a higher average frequency (i.e., 38.32 instances per million words) than the marijuana-related words (i.e., 15.40 instances per million words). This discrepancy was unavoidable and, as a

result, neutral words were chosen so their average frequency fell between the alcohol and marijuana words (i.e., 23.80 instances per million words).

The presentation of the word primes was randomized and based upon a method utilized by Soler et al. (2015). Word primes were presented in the center of the computer screen for 8 seconds each. After each word presentation, participants were asked to rate their familiarity with the word on a 7-point Likert scale from 1 (*unfamiliar word*) to 7 (*very familiar word*). After the presentation of the word primes and prior to the start of the WSC task, participants in the prime conditions performed a distracter task in which they were asked to provide the names to as many American cities as possible in a 5-minute period. As previously noted, those in the no-prime condition were not presented with either the primes or the distracter task.

**WSC.** The WSC task was intended to assess attentional bias towards marijuana and alcohol-related words. The task consists of 51 multi-solution word stems that are the first letters of a word followed by blanks (e.g. BO\_ \_). See Appendices A through C for lists of the word stems used in the current study. A similar style of word stems task was utilized by Soler et al. (2015) and Gellatly, Parker, Blurton, and Woods (1994). For the purposes of the current study, 34 of the word stems were target stems with 17 alcohol- and 17 marijuana-related words as possible solutions. The presentation of the 51 word stems was randomized across participants. Target word stems were chosen after surveying marijuana-related websites and identifying those words that appeared frequently, were uniquely related to marijuana and alcohol culture, and had stems that could be completed with words unrelated to marijuana or alcohol. Neutral words were selected that best matched the marijuana and alcohol words on frequency and length.

As noted, each stem could be completed in several ways, including a primed substance solution, a non-primed solution, and no solution. Misspelled words were included in the analysis if two separate judges agreed to their meaning. The stems completed with substance-related and primed neutral words were summed to produce scores for each participant.

**Alcohol Use Disorder Identification Test (AUDIT).** Alcohol use, as well as problematic alcohol use, was measured through the Alcohol Use Disorder Identification Test (AUDIT). AUDIT is a 10-item measure of problematic alcohol use. Each item has five possible responses with each response associated with a specific score ranging from 0 to 4. AUDIT is scored by adding each of the 0 to 4 item scores into a total score. Although a cut-off was not used in the current study, problematic use is determined by a total score of greater than eight. This cut-off is well established as the point where problematic alcohol use is very likely (Babor, Higgins-Biddle, Saunders, & Monteiro, 2001). AUDIT has repeatedly been shown to have good construct validity. In a study of intoxicated drivers, it was found that first time offenders had lower AUDIT scores than repeat offenders (Hays et al., 1993). AUDIT also has strong internal reliability with Cronbach's alphas from .77 in primary care patients to .94 in substance abusers (Allen, Litten, Fertig, & Babor, 1997).

In the current study, the AUDIT had a Cronbach's alpha of 0.859. Alcohol use was assessed using the first three items of the AUDIT, considered the Alcohol Use Identification Test – Consumption (AUDIT-C). The questions include: 1) *How often do you have a drink containing alcohol;* 2) *How many drinks containing alcohol do you have on a typical day when you are drinking;* and 3) *How often do you have six or more drinks on one occasion?* The AUDIT-C in this investigation had a Cronbach's alpha score of 0.641. Bradley et al.

(2007) assessed the validity of the AUDIT-C and found that it performs as well as the full AUDIT and better than self-reported risky drinking at identifying alcohol misuse. For each participant, scores on the first three items (AUDIT-C) were summed to produce a total score with higher scores indicative of heavier use.

**Cannabis Use Disorder Identification Test–Revised (CUDIT-R).** Marijuana use, as well as problematic marijuana use, was measured through the CUDIT-R. CUDIT-R is an 8-item measure of problematic marijuana use. Each item has five possible responses with each response associated with a specific score ranging from 0 to 4. The CUDIT-R is scored by summing the individual item scores to produce a total score. The CUDIT-R has strong test-retest reliability  $r=0.871$  (Adamson et al., 2010). In the current study, the CUDIT-R had a Cronbach’s alpha score of 0.860. Previous studies have identified that 91.3% of those with a score of 13 or higher on the CUDIT-R have a current diagnosis of cannabis use disorder, indicating that it is both a reliable and valid measure of marijuana use disorder.

Marijuana use was measured in a similar fashion to alcohol use by isolating the first three questions of the CUDIT-R and summing the individual item scores to form the CUDIT-C. Those items are: 1) *How often do you use cannabis*; 2) *How many hours were you “stoned” on a typical day when you had been using cannabis?*; and 3) *How often during the past 6 months did you find that you were not able to stop using cannabis once you had started.* In the current study, the CUDIT-C had a Cronbach’s alpha score of 0.679.

**Alcohol Craving Questionnaire Short Form Revised (ACQ-SF-R).** The ACQ-SF-R was used to assess state craving for alcohol. Prior literature indicates that state craving for a substance may influence cognitive biases for that substance (Field & Cox, 2008). The ACQ-SF-R consists of 12 questions rated on a 7-point Likert scale from 1 (*strongly agree*) to



7 (*strongly agree*) and evaluates alcohol craving on four factors: 1) compulsivity, lack of control over alcohol use; 2) emotionality, alcohol use with the expectation of relief from negative emotions or feelings; 3) expectancy, alcohol use with the expectation of positive outcomes from use; and 4) purposefulness, planning alcohol use. Higher total scores indicate higher levels of craving, while high scores on individual subscales indicate their predominance as a factor in the participants craving. The ACQ-SF-R is a shortened version of the ACQ developed by Singleton et al. (unpublished manuscript). The reliability, estimated with a Spearman-Brown formula, of the 40-item version of the ACQ is 0.97. An analysis by Tiffany, Carter, and Singleton (2000) demonstrated that a shorter 13-item version of the ACQ-SF-R would have a reliability estimate of over 0.90. This measure has a strong internal consistency with Cronbach's alpha ranging from 0.77 for factor 2 (*expectancy*) and factor 3 (*purposefulness*) and 0.86 for factor 4 (*emotionality*) (Allen, 2003). In the current study, the Cronbach's alpha score for the full ACQ-SF-R was 0.887.

**Marijuana Craving Questionnaire Short Form (MCQ-SF).** The MCQ-SF was used to assess state craving for marijuana because prior literature indicates craving for a substance may influence cognitive biases for that substance (Field et al., 2004). The MCQ-SF consists of 12 items rated on a 1 (*strongly disagree*) to 7 (*strongly agree*) 7-point Likert scale. The MCQ-SF evaluates marijuana craving on four factors: 1) compulsivity, lack of control over marijuana use; 2) emotionality, marijuana use with the expectation of relief from negative emotions or feelings; 3) expectancy, marijuana use with the expectation of positive outcomes from use; and 4) purposefulness, planning marijuana use. Higher total scores indicate higher levels of craving, while high scores on individual subscales indicate their predominance as a factor in the participant's craving.

The MCQ-SF was developed by Heishman, Singleton, and Liguori (2001) and has been shown to have construct validity in that all four factors are significantly correlated with past month marijuana craving. The MCQ-SF also has good reliability with previously reported Cronbach's alphas ranging from 0.55 for expectancy and 0.82 for compulsivity (Heishman et al., 2001). In the current study, the MCQ-SF had a Cronbach's alpha score of 0.929. The MCQ-SF has been used to evaluate craving for marijuana in previous studies. In one such study, the MCQ-SF was utilized to detect increased craving from stress (McRae-Clark et al., 2011). In another study, the MCQ-SF was utilized to detect craving in adolescents during pharmacological assisted cessation trials (Roten, Baker, & Gray, 2013).

### **Procedure**

This study was conducted online. Upon signing up for the study, participants were directed to a Qualtrics survey page where they were presented with an informed consent document and asked to confirm that they are at least 21 years of age and lived in a state or district with legal recreational marijuana use. Each participant was then presented with the demographics page with questions regarding age, gender, education, race, and income. See Appendix D for details. Each participant was randomly assigned into a priming condition. Those in the substance-related and neutral prime conditions were presented at random with the prime words. The prime words appeared in the middle of the screen for eight seconds. Each word was followed by a new page with a question assessing how familiar the participant was with the previously presented word, which was rated on a 7-point Likert scale from 1 (*unfamiliar word*) to 7 (*very familiar word*). After the primes, participants completed a distracter task asking them to name as many American cities as possible in 5 minutes. The

WSC task was then presented. Those in the no-prime condition were presented with the WSC task immediately after the demographics page.

At the beginning of the WSC, each participant was presented with an example word completion stem and instructions for the WSC.

“Please fill in the blanks with letters to make a word”

Example: RO\_ \_

Answer: ROPE

“Please answer each question as quickly as possible”

The word completion stems in the WSC were randomized across participants in order to avoid potential order effects. All participants were presented with 51-word completion stems and asked to fill in the blanks with letters to make a word. Participants were not able to skip items without entering letters. The WSC took approximately 15 minutes to complete. Upon completion of the WSC, each participant was presented with the AUDIT, CUDIT-R, ACQ-SF-R, and MCQ-SF in counterbalanced order.

## **Design**

This study had one independent variable consisting of the prime condition (No-prime, Neutral-prime, Substance-related prime) with participants completing word stems in the WSC task. Substance craving and substance use were included as potential covariates to determine and control for their influence on the potential priming effect. Craving was assessed by the ACQ-SF-R and MCQ-SF. Use of alcohol and marijuana were assessed through the AUDIT, AUDIT-C, CUDIT-R, and CUDIT-C.

## **Statistical Analyses**

Each participant generated the following data: (a) demographic information, including age, gender, race, education, and possession of a medical marijuana prescription; (b) total stem completions for neutral words, alcohol-related words, and marijuana-related words; (c) alcohol and marijuana craving scores; and (d) amount of marijuana and alcohol use. In order to evaluate the effect of priming on each WSC word category, an MANCOVA was used to compare the completion rate for each stem word type (i.e., alcohol, marijuana, and neutral) across the three priming conditions (i.e., Substance-related, Neutral, No-prime). Covariates included alcohol and marijuana craving and usage levels. As previously noted, it was hypothesized that there would be a main effect of priming condition with the substance-related prime and neutral prime conditions showing higher completion rates with their respective primed words. It was also hypothesized that marijuana and/or alcohol use, as well as craving, would be significant covariates, influencing the rate of WSC for both alcohol- and marijuana-related words.

## CHAPTER III

### RESULTS

Participants completed the AUDIT which contained the AUDIT-C as a subset of questions, the CUDIT-R which contained the CUDIT-C as a subset of questions, the ACQ-SF-R, and the MCQ-SF. See Table 1 for details.

Table 1

*Descriptive Statistics*

	<i>N</i>	Min	Max	Mean	<i>SD</i>
AUDIT-C	100	3.00	14.00	6.26	2.50
CUDIT-C	100	3.00	15.00	4.90	2.63
AUDIT	100	10.00	39.00	15.29	5.71
CUDIT-R	100	8.00	37.00	11.98	5.90
ACQ-SF-R	100	1.50	5.75	2.70	1.04
MCQ-SF	100	1.00	6.08	2.50	1.45

The AUDIT scores observed in the current study were higher than that reported in a previous investigation of a sample of 318 college students from South Africa ( $M = 8.23 \pm 4.02$ ; Young & Mayson, 2010). In contrast, the average ACQ-SF-R score in the current study was lower than in the original validation study of the scale ( $M = 3.44$ ; Singleton, Tiffany, & Henningfield, 2014). The CUDIT-R scores were slightly higher than those of a previous investigation with French high school students ( $M = 10.75 \pm 6.84$ ; Chabrol, Ducongé, Casas, Roura, & Carey, 2005) and MCQ-SF scores were lower than those of a study investigating two different groups of marijuana dependent individuals ( $Ms = 45.6 \pm 15.2, 48.1 \pm 16.3$ ; McRae-Clark et al., 2011).

All the surveys were positively correlated with one another. The AUDIT was significantly correlated with both the AUDIT-C and the ACQ-SF-R,  $r(98) = 0.826, p < 0.001$  and  $r(98) = 0.644, p < 0.001$  respectively. Correlations between AUDIT and AUDIT-C were expected given the overlap in questions. The CUDIT-R was significantly correlated with the CUDIT-C and the MCQ-SF,  $r(98) = 0.927, p < 0.001$  and  $r(98) = 0.705, p < 0.001$ , respectively. Correlations between CUDIT-R and CUDIT-C were expected given the overlap in questions. Specifically, marijuana use as measured by the CUDIT-C was positively correlated with marijuana craving as measured by the MCQ-SF,  $r(98) = 0.697, p < 0.001$ , and the AUDIT-C was positively correlated with alcohol craving as measured by the ACQ-SF-R,  $r(98) = 0.589, p < 0.001$ . The AUDIT-C and CUDIT-C were also positively correlated with one another,  $r(98) = 0.494, p < 0.001$ . Overall performance in producing marijuana-related words in the WSC task correlated with both the production of alcohol-related words and of neutral words. See Table 2 for details.

For those in the substance-related prime condition, familiarity with alcohol-related words was positively correlated with the rate of alcohol word production,  $r(98) = 0.517, p < 0.05$ . In contrast, for those in the neutral prime condition, familiarity with the neutral words that were selected to be equivalent to the alcohol words in the substance-related prime was negatively correlated with the rate of producing those same neutral-but-equivalent words,  $r(98) = -0.530, p < 0.05$ . No other correlations were observed between reported familiarity with the words during the priming phase of the experiment and performance in the WSC task. Overall, during the word prime presentation, participants reported mean word familiarity of  $6.6 \pm 0.4$  in the neutral prime condition and  $5.8 \pm 0.9$  in the substance-related prime condition. In just the substance-related prime condition, the mean familiarity of the alcohol primes was

Table 2

*Correlations Among Measures*

	Marijuana words	Alcohol words	Neutral words	AUDIT-C	CUDIT-C	ACQ-SF-R
Marijuana words	-					
Alcohol words	.673**	-				
Neutral words	.267**	.103	-			
AUDIT-C	.014	.190	-.071	-		
CUDIT-C	-.061	-.080	-.108	.494**	-	
ACQ-SF-R	-.168	.073	-.099	.589**	.409**	-
MCQ-SF	-.101	-.009	-.173	.439**	.697**	.507**

\*\*Correlation is significant at the  $p < 0.01$  level (2-tailed).

rated as  $6.3 \pm 0.3$ , the marijuana primes was  $5.2 \pm 1.2$ , and the neutral primes was  $5.8 \pm 0.6$ . The goal in selecting the neutral primes was to match the substance-related primes in familiarity. In the neutral prime condition, the alcohol-equivalent neutral primes were rated as  $6.2 \pm 0.4$ , the mean familiarity of the marijuana-equivalent neutral primes were rated as  $6.6 \pm 0.6$ , and the mean for the neutral primes was rated as  $6.8 \pm 0.2$ . The average number of cities listed during the distracter task in the substance-related and neutral-prime conditions were 35.2 cities.

A multiple analysis of covariance (MANCOVA) assessed the impact of the factor of primed condition (No-prime, Neutral prime, Substance-related prime) and the covariates of the AUDIT-C, CUDIT-C, ACQ-SF-R, and MCQ-SF on the dependent variables of the number of alcohol-related words, marijuana-related words, and neutral words produced during the WSC. Prior to the MANCOVA, three outliers who were all female and were defined as those participants who had values exceeding the mean plus/minus two times the standard deviation were removed from the analysis. The number of alcohol-related words and marijuana-related words then underwent a square root transformation to correct for heteroscedasticity, while the neutral word completion rate underwent an inverse transformation to correct for the same problem. The consumption factors of the AUDIT-C and CUDIT-C were selected as covariates over the AUDIT and CUDIT. Box's M test of equality of covariance,  $F(12, 42249.435) = 1.297$ ,  $p = 0.212$ , indicated homogeneity of the covariance matrices.

The MANCOVA revealed that the priming condition significantly affected the combined dependent variables of the three types of word stem solutions, Wilks'  $\lambda = 0.532$ ,  $F(6, 176) = 10.881$ ,  $p < 0.001$ , multivariate partial  $\eta^2 = 0.271$ . The AUDIT-C covariate



significantly affected the combined dependent variable of the three word stem solutions, Wilks'  $\lambda = 0.908$ ,  $F(3,88) = 2.979$ ,  $p < 0.05$ , multivariate partial  $\eta^2 = 0.092$ . For each word stem solution type, univariate analyses of variance covariance (ANCOVA) was conducted as a follow-up test to the MANCOVA.

ANCOVA results indicated that the production rate of marijuana-related words and alcohol-related words were significantly affected by the priming condition,  $F(2,93) = 20.656$ ,  $p < 0.001$ , partial  $\eta^2 = 0.315$  and  $F(2,93) = 26.501$ ,  $p < 0.001$ , partial  $\eta^2 = 0.371$ , respectively. For the production rate of alcohol-related words, the AUDIT-C was also a significant covariate,  $F(1,93) = 8.492$ ,  $p < 0.01$ , partial  $\eta^2 = 0.086$ . For the production rate of marijuana-related words, the ACQ-SF-R was an unexpected significant covariate,  $F(1,93) = 6.181$ ,  $p < 0.05$ , partial  $\eta^2 = 0.064$ . Post-hoc comparisons of unadjusted means revealed that participants produced more alcohol-related and marijuana-related words following the substance prime than following either the neutral prime or no-prime conditions ( $ps < 0.05$ ). See Table 3 for details. There were no differences between adjusted and unadjusted means.

Table 3

*Adjusted Means of Transformed and Untransformed Data*

Prime	Marijuana words		Alcohol words		Neutral words	
	Transformed	Untransformed	Transformed	Untransformed	Transformed	Untransformed
Substance	1.780	3.516	2.154	4.968	0.560	3.968
Neutral	0.964	1.176	1.128	1.647	0.529	3.941
No-Prime	0.934	1.281	1.332	2.187	0.621	2.969

## CHAPTER IV DISCUSSION

WSC tasks are designed to test the capabilities of implicit memory systems. These tasks prime participants with a word and later ask those same participants to solve a stem task where the previously presented word is a possible solution. Importantly, the tendency to solve the stem with the previously viewed word occurs despite participants' purported lack of conscious memory of having seen the word. For example, amnesic individuals are capable of producing primed words at a rate similar to those with no memory impairment (Cermak, Mather, & Hill, 1997). Cermak et al. (1997) investigated amnesiacs' ability to solve a primed word stem task and found that they were able to produce primed words at greater rates than chance. This occurred even after participants were asked not to solve the stem with the primed word. In the control group, such instructions decreased the rate of primed word production. It is, therefore, hypothesized that word stem tasks utilize a different memory system than explicit memory and implicit systems may be influenced by factors outside of an individual's conscious awareness. In the current study, it was hypothesized that heavy substance use or substance craving would impact implicit memory systems making substance-related stimuli more easy to recall or encode.

Cognitive biases for addictive substances have been more thoroughly investigated with other measures of implicit memory or cognition than WSC tasks. Many of these measures examined approach and attentional biases for the substance in question (Rooke et al. 2008). Implicit measures of cognitive biases assess associations between constructs that one may not realize or want to acknowledge and have been found to be heavily associated with substance use and abuse, likely playing a role in relapse (Field & Cox, 2008). It has also been

found that modification of these biases are possible and can result in better addiction treatment outcomes (Kakoschke et al., 2017).

The current study examined the effects of alcohol and marijuana use on a primed word stem task. For the participant to be eligible for the study, they had to have used both alcohol and marijuana at least once in their lifetime. Participants were divided into conditions where they were exposed to a substance-related prime, a neutral prime, or no-prime and were, after a distracter task, asked to solve word stems with the first word that came to mind. In the current study, the surveys of alcohol and marijuana use (i.e., AUDIT-C, CUDIT-C), as well as cravings (ACQ-SF-R and MCQ-SF), were all correlated with one another, indicating that alcohol and marijuana use was not only correlated with one another but that cravings for these substances are also associated. Such observed correlations between alcohol and marijuana use and cravings were likely due to high polysubstance use in the sampled participants; an expected finding given that cannabis is the most commonly used drug among those who drink (Subbaraman & Kerr, 2015). It may also have been a result of the recruitment criteria that required participants to have consumed, at least once for each drug, both alcohol and marijuana.

The word prime conditions utilized in the current study were effective as implicit memory tasks. Those participants in the substance-related prime produced significantly more substance-related words in the WSC task than did participants in either the no-prime or the neutral prime condition. There were no differences in WSC task performance between the no-prime and neutral prime conditions; a finding which may have resulted from floor effects in both conditions as scores for total words produced were low relative to the substance-related prime condition. Importantly, alcohol consumption as measured by the AUDIT-C

significantly affected the production of alcohol-related words, providing evidence of a cognitive bias for alcohol following priming of substance-related words in those who use more alcohol. This cognitive bias appears to be unique to alcohol use as marijuana use was not associated with the production of more marijuana-related words with or without priming.

### **Priming Effects**

As noted, previous investigations have demonstrated the efficacy of priming on the WSC task (Cermak et al., 1997; Soler et al., 2015). Soler et al. (2015) investigated the efficacy of priming on a word stem task and demonstrated that there was a significant priming effect on multiple solution word stems, much like those used in the current investigation. Cermak et al. (1997) found that even amnesiacs were susceptible to priming effects despite no explicit recollection of the word list. The current study replicates those prior findings in that priming significantly affected the rate of word stem completion. Those in the substance-prime condition produced significantly more substance-related words than those in the control or neutral conditions. This priming effect was specific for substance-related words because there was no effect of the neutral prime on the number of substance-related or neutral word stem completions.

As noted, the no-prime and neutral prime conditions resulted in very low word production, with participants in those conditions averaging less than two marijuana-related words, less than four neutral words, and an average of between one and three alcohol-related words. In contrast, individuals in the substance-related prime condition averaged more than three marijuana-related words and almost five alcohol-related words. The substance-related prime did not alter the average number of neutral words compared to the other prime conditions. These findings coincide with other reports of the efficacy of priming on

substance-related WSC tasks (Kemps, Tiggemann, & Hollitt, 2014b; Soler et al., 2015). For example, Kemps et al. (2014b) found that those exposed to food-related television advertisement produced more food-related words. The findings of the current investigation demonstrate that alcohol and marijuana priming can increase the rate of production of alcohol- and marijuana-related words on a word stem task. This indicates that the prime effectively altered the cognition of the participant, allowing certain word solutions to more easily come to mind in response to specific stems.

### **Drug Use and Craving Surveys**

As previously mentioned, the surveys investigating marijuana and alcohol use and craving were all significantly correlated with one another, suggesting that the surveys measured related constructs. For example, alcohol consumption is conceptually related to alcohol craving. Although the marijuana and alcohol surveys were correlated with one another, the correlations between alcohol consumption as measured by the AUDIT-C and the alcohol craving as measured by the ACQ-SF-R were more strongly correlated with one another than they were correlated with the marijuana use and craving surveys. The same was true for the marijuana surveys with the CUDIT-C and MCQ-SF more strongly correlated with one another than with the alcohol use and craving surveys. Due to the high levels of polydrug use as reported in the literature (Subbaraman & Kerr, 2015) and the fact that recruitment procedures were limited to those individuals who had used alcohol and marijuana at least once in their lifetime, it was expected that the alcohol and the marijuana use surveys would be associated. Future investigations may benefit from adding additional conditions in which polydrug users are compared to monodrug users to examine these effects without crossover between substances.

Prior investigations that utilized the MCQ-SF have reported inconsistent results. Field et al. (2004) found that craving was correlated with attentional bias but was not correlated with marijuana consumption. In contrast, Metrik et al. (2016) found that craving was not associated with attentional bias. The current investigation found a correlation between consumption and craving but no association between marijuana craving, consumption, and marijuana-related words, indicating a lack of effect of marijuana use or craving on cognitive bias. Previous studies using the ACQ-SF-R found that that survey was related to lower levels of self-control as measured by an Implicit Association Test (Lindgren, Neighbors, Westgate, & Salemink, 2014). The current study found that ACQ-SF-R impacted marijuana-related words but not alcohol-related words, suggesting that alcohol craving may influence cognitive bias for other substances.

As noted above, alcohol consumption and alcohol craving both significantly influenced the production of substance-related words. Alcohol consumption increased the rate at which alcohol-related words were produced. These results are consistent with the findings of Kemps et al. (2014b) who found that obese individuals produced more food-related words compared to those of normal weight after being shown food-related advertisements. These results also are consistent with the findings of McCusker and Gettings (1997) who found that gamblers produced more gambling-related words than controls. There are few studies that have investigated cognitive biases for substances with a WSC task, so the current study establishes that it is possible to detect such biases with such a task. The current investigation, however, would have been aided by including a non-drug use control group to include in comparisons in order to better determine the extent of the cognitive bias associated with specific drug use.

Studies investigating heavy marijuana use and cognitive biases found that heavy marijuana use was associated with attentional bias in a Stroop task (Cousijn et al., 2013). The current investigation did not find that marijuana use was associated with a cognitive bias. The discrepancy may be due to the Stroop task being more sensitive to cognitive biases than a WSC task because the Stroop task measures response time in milliseconds and can detect slight hesitations in response latency that may reveal subtle or weaker cognitive biases. An alternative approach to investigating the extent of cognitive biases associated with marijuana use would be to include no-use and low-use marijuana groups rather than comparing marijuana use and craving on a linear scale. For example, cognitive bias in marijuana users as examined in a visual dot-probe task determined that heavy use was associated with an attentional bias for marijuana-related words (Field et al., 2004) but that those with low levels of craving did not have an attentional bias for marijuana-related word cues. Thus, the wide range of marijuana use profiles included in the current sample may have masked the impact of marijuana use on cognitive or attentional biases. Alternatively, the lack of association between marijuana craving and the production of marijuana-related words may be indicative of a lack of sensitivity within the WSC task or that biases in implicit memory for marijuana are not influenced by a craving for marijuana in the majority of users.

Previous investigations into alcohol and attentional biases found that heavy alcohol use is associated with cognitive bias (Field et al., 2004). This is congruent with the findings of the current investigation in which increases in alcohol consumption influenced the production rate of alcohol-related words. Unlike the previous investigation by Field et al. (2004), there was no association found between the production of alcohol-related words and alcohol craving in the current study. However, the current study did find that alcohol craving



influenced the production of marijuana-related words. The reason for the differing results between studies is unclear but may be related to the sensitivity of the WSC task. Further investigations are required to determine the best conditions for revealing biases in implicit memory due to drug craving. Overall, however, there is evidence that a WSC task is capable of detecting biases in implicit memory as utilized in the current study.

Alcohol craving decreased the rate at which marijuana-related words were produced. These results were unexpected and cannot be explained by differences between the prime conditions as each were similar in response levels on the alcohol craving questionnaire. There is not a clear explanation for this finding as no known previous investigations have reported such a result. In fact, with the high instance of polysubstance use in this sample, the opposite result in which alcohol craving increased marijuana-related word production was expected. One possible explanation could be that the participants in the current sample do not use both alcohol and marijuana simultaneously but, instead, use them concurrently, resulting in a dissociation between the substances. Future investigations will be required to determine the actual reasons behind this association.

Overall, the current study demonstrated a significant influence of alcohol consumption on the production rate of alcohol-related words on a primed WSC task. This suggests that there is an effect of alcohol consumption on implicit memories regarding alcohol. It would seem that once exposed to an alcohol-related cue, the memory of that event is more easily retrieved in a heavy user compared to a lighter user. The same cannot be said for marijuana consumption. The rate of marijuana consumption did not significantly affect the rate at which marijuana or alcohol-related words were produced and neither did marijuana craving.

## **Limitations of the Current Study**

One of the limitations of the current investigation was the lack of control groups with participants with a minimal amount of marijuana and alcohol use. It would be useful to compare a population that does not use marijuana or alcohol to one that does. Increased variance in the substance use of the sample may reveal effects of alcohol and marijuana use on the word stem tasks. It would also be beneficial to test different word lists to determine if the current findings are consistent with other substance-related word stems or primes. Different sets of words may reveal increased or decreased effects of alcohol and marijuana use on the stem tasks.

The current study demonstrated an impact of alcohol use on primed word stem tasks, suggesting the existence of a bias in implicit memory. It would appear that those who consume more alcohol have an easier time producing alcohol-related and marijuana-related words after a prime. In future investigations, larger sample sizes with a larger variety of word primes and stems could identify those words and stems that most accurately assess problematic alcohol or marijuana use, consumption, and craving. As noted, it may also be beneficial to utilize a participant sample with a larger variation in the amount of substance use, ranging from no use to very heavy consumption. In addition, other priming methods could also be investigated, such as television advertising or semantic associations.

It appears that word stem tasks can assess cognitive biases in addictive behaviors, although there is a need for further development. It has been previously demonstrated that cognitive biases for gambling can be detected through the use of word stem tasks (McCusker & Gettings, 1997) as well as accessibility of food-related cognitions (Kemps et al., 2014b). The current study adds to this literature by demonstrating that biases can be identified in

those that use alcohol, expanding the range of cognitive biases that can be assessed with word stems. This study also furthers the development of a useful word stem task for the assessment of cognitive biases in those with substance use disorders.

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## APPENDIXES

### APPENDIX A

#### Word Stems and Primes – Marijuana Primes

##### **Marijuana Primes**

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Substance prime condition	Word stem presented	Non-substance prime condition
Blunt	bl	blank
Bogart	bog	bogeys
Bong	bo	boot
Buds	bu	bull
Cannabis	can	cannibal
Dank	da	dart
High	hi	hike
Joint	jo	jolly
Kief	ki	kite
Reefer	re	refund
Roach	ro	roast
Sativa	sat	saturn
Stoned	sto	stores
Strain	st	stream
Weed	we	wear
Kush	ku	kudo

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## APPENDIX B

### Word Stems and Primes – Alcohol Primes

#### Alcohol Primes

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Substance prime condition	Word stem presented	Non-substance prime condition
Alcohol	alc	alchemy
Scotch	sco	scores
Whiskey	whi	whistle
Beer	be	bear
Shots	sh	shape
brandy	bra	brains
Vodka	vo	voted
Lager	la	lance
Wine	wi	wind
Cocktail	coc	cockatoo
Drink	dr	drive
Mixer	mi	miner
Martini	mar	married
Drunk	dr	drain
Bottle	bot	bottom
Bourbon	bou	boulder

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## APPENDIX C

### Word Stems and Primes – Neutral Primes

#### Neutral Primes

Non-substance prime condition	Word stem presented
actual	act
motive	mo
coffee	co
quicker	qui
bridge	bri
dust	du
apple	ap
flash	fl
grip	gr
rusty	ru
base	ba
delta	de
fork	fo
brick	br
cement	cem
snail	sn

## APPENDIX D

### Demographics

Please answer each question accurately and honestly by selecting the option that best represents you or filling in the answer in the space provided.

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1. What is your year of birth?

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2. What is the highest level of school you have completed or the highest degree received?

- Less than high school
  - High school graduate (High school diploma or equivalent including GED)
  - Some college but no diploma
  - Associate degree in college (2-year)
  - Bachelor's degree in college (4-year)
  - Master's degree
  - Doctoral degree
  - Professional degree (JD, MD)
- 

3. Choose one or more races that you consider yourself

- White
- Black or African American
- American Indian or Alaskan native
- Asian
- Native Hawaiian or Pacific Islander
- Spanish, Hispanic, Latino/Latina



- Other
- 

4. What is your gender?

- Male
  - Female
  - Other (with blank)
- 

5. What is your ZIP code?

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6. Do you have a prescription for medical marijuana?

- No
  - Yes
-