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Whatcha' Looking At? A measure of the impact of individual differences in drug and alcohol  
experience on attentional bias and memory associations

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### Abstract

**Aims:** This study examined whether attentional bias to alcohol and marijuana cues is related to recency and frequency of alcohol and marijuana use in a non-clinical population and compared it with other indirect measures of substance use associations.

**Method:** Times spent looking at alcohol and marijuana cues in pictures were recorded using eye-tracking. Participants also completed cognitive tasks and a survey.

**Findings:** Time spent looking at cues was a good predictor of frequency of alcohol and marijuana use. The new measure was correlated with the other cognitive measures of substance use associations.

**Conclusions:** Attentional bias was found in individuals who are non-clinical substance users. Visual cues associated with substance use elicit attention and may potentially index motivation to use.

## Introduction

### *Introduction*

Drug and alcohol use is prevalent among adults and adolescents in North America. In Canada, 82.9% of adolescents and young adults ages 15-24 years have drunk alcohol in the past 12 months while 36.1% of those drinkers drink hazardously (Flight, 2006). More than twice as many adolescents and young adults drink hazardously, compared to adults over age 25 years (13.4%). Although many young people get through these perilous years safely, many others experience significant health and social consequences. For example, almost one-quarter of adolescents who drink alcohol report self-harms specifically due to their own drinking, such as difficulties in friendships and social life, physical health, finances, and studies. Also, almost 60% of older adolescents, aged 18-19 years, reported experiencing harm done by others due to others drinking and drug use in the past year (e.g., pushing, humiliation, verbal abuse, and quarrels) (Flight, 2006). Identification of those individuals with a higher risk to transition to substance use or to experience these problems would be useful in developing interventions that target these individuals for prevention and treatment efforts.

There are many approaches to assessing risk in adolescents. Recently, researchers have developed and tested many cognitive measures in an attempt to identify individuals who drink alcohol and use substances hazardously and to understand the cognitive processes that lead to substance use (e.g., Gilbert et al., 2007; Noël et al., 2007; Robbins & Ehrman, 2005; Robinson & Berridge, 2003; Schoenmakers, Weirs, Hones, Bruce, & Jansen, 2007; Stacy, 1995; Stacy, 1997; Thush et al., 2008). This thesis explores a recently proposed cognitive measure of substance use risk, attentional bias (Field, Mogg, & Bradley, 2006; Schoenmakers et al., 2007). The attentional bias measure is intriguing for two reasons: it predicts substance use tendencies indirectly and

possibly without awareness, and it is based on a strong theoretical model of substance use decisions processes (Franken, 2003).

Measures of cognitive processes contributing to substance use decisions often focus on the associations between substance use behaviours, substance use context, and substance use outcomes. For example, many studies have examined alcohol outcome expectancies (Goldman, 2006). Alcohol outcome expectancies are measures of the anticipated effects of alcohol use. Put another way, these expectancies are based on associations between substance use and its outcomes. Such outcome expectancies contribute to substance use decisions through incentive motivation. Simple stated, incentive motivation is the increased tendency to choose behaviours with more positive anticipated consequences (Field et al., 2006; Franken, 2003; Robinson & Berridge, 2003; Noël et al., 2007; Thush et al., 2008). Cognitive measures thought to index incentive motivation with respect to substance use have been particularly useful in predicting substance use (Goldman, 2006; Field et al., 2006; Franken, 2003; Robinson & Berridge, 2003; Noël et al., 2007; Thush et al., 2008). In order to understand incentive motivation of drug and alcohol use, researchers need to consider the types of memory associations' individuals have between using drugs and alcohol and subsequent outcomes, as well as expectancies surrounding the anticipated outcomes of using substances (e.g., Field et al., 2006; Hermans, Vansteenwegen, Crombez, Baeyens, & Eelen, 2002; Noël et al., 2007; Palfai, 2002; Stacy, 1997; Thush et al., 2008). This theory will be discussed further below.

### *Implicit and explicit memory*

Two types of memory may be measured when looking at substance use associations and what motivates individuals to do certain behaviours: explicit and implicit memory (Charash, McKay, & Dipaolo, 2006; Thush et al., 2008). In explicit memory, an individual can consciously

recall and consider the items. By contrast, implicit memories are not consciously known. Implicit memory is memory without awareness (Charash et al., 2006). Implicit memory provides a different look at why individuals are motivated to do something. Cognitive tasks thought to measure implicit memory have been shown to predict not only concurrent substance use, but also future changes in substance use such as the initiation of first time use or the escalation of moderate use. Indeed, several researchers argue that implicit substance use associations may uniquely index an important form of incentive motivation, that is the unconscious influence of anticipation of positive consequences from a behaviour, such as substance use. Implicit memory requires indirect ways of measuring memory without awareness. Implicit memory measures fall under the general rubric of indirect memory tasks.

#### *Direct and Indirect Measures*

Some measures of memory associations relevant to substance use employ direct methods of assessment. For example, alcohol outcome expectancy tasks often ask directly about what would happen if you “used alcohol”? Alternatively, they may ask how likely is it that if you drank alcohol that an outcome, such as “talk more”, would happen. These measures are direct because they ask specifically about the behaviour in question. Recently, several investigators have developed cognitive measures that indirectly measure an individual’s associations with substance use (Schoenmakers, et al., 2007; Stacy, 1995; Stacy, 1997). Indirect measures uncover the strength of a substance use association without directly asking the participant about it (Stacy, 1995; 1997; Stacy, in press; Wiers et al., 2006).

Such indirect measures are important because they measure a different aspect of memory. Researchers argue that individuals may be unable to identify what motivates them to use substances and, therefore, cannot accurately report their motivations to use (Charash et al., 2006;

Franken, 2003). While there is evidence for this, it has also long been understood that unconscious thought-processes and memories play a role in reasoning and behaviour. Implicit memory, that is, learned knowledge, perceptions, and memory associations, can influence behaviour without conscious awareness (Charash et al., 2006; Wiers et al. 2006). Indirect measures may capture these unconscious influences and reflect the role of implicit memories. Although there is much debate about the cognitive structures that underlie implicit versus explicit memories, indirect measures of substance use associations independently predict substance use over and above direct measures. Unconscious influences may be an important part of this additional predictive value for substance use.

Three indirect measures have been especially successful in predicting substance use: ambiguous word task, behaviour associates task, and attentional bias (e.g., Franken, 2003; Mogg, Field, & Bradley 2005; Robbins & Ehrman, 2005; Schoenmakers, et al., 2007; Stacy, 1995; Stacy, 1997; Wiers et al., 2006). Specifically, the ambiguous word task and the behaviour associates task have been successful in predicting substance use through measuring memory associations between drug or alcohol cues and responses (Stacy, 1995; Stacy, 1997; Stacy, Dent, Sussman, & Raynor, 1990). Attentional bias has been successful in predicting substance use through measuring attentional bias to substance related cues (e.g., Mogg et al., 2005; Wadlinger & Isaacowitz, 2008; Wiers & Stacy, 2006). For this study, we developed a novel measure of attentional bias toward drug and alcohol cues. Given unique aspects of attentional bias, it has the promise of providing unambiguous implicit memory measures of incentive motivation.

#### *Attentional bias*

Behaviourally, attentional bias is the tendency for a stimulus to attract and hold attention. Such effects may be the result of novelty or association of the stimulus with threat (Calvo &

Avero, 2005; Calvo & Lang, 2004) or reward (Krank et al., 2008). This latter relationship is directly related to incentive motivation where the tendency to visually approach a stimulus associated with reward correlates with other measures of incentive motivation (Field et al., 2006; Krank et al., 2008). Thus, measures of attentional bias to substance use stimuli would be expected to index incentive motivation and consequently substance use behaviours (Field et al., 2006; Krank et al., 2008).

Researchers have used many different cognitive measures of attentional bias towards drug and alcohol cues. Indirect measures measure cognitive processes without the individuals' awareness (Robbins & Ehrman, 2005; Wiers & Stacy, 2006). These include, but are not limited to, the stroop-task, dot-probe task, and eye-tracking (Balcetus & Dunning, 2006; Mogg et al., 2005; Robbins & Ehrman, 2005; Wadlinger & Isaacowitz, 2008; Wiers & Stacy, 2006). Briefly, the stroop-task measures whether certain stimuli, such as drugs or alcohol words, delay responding to experimental tasks, such as naming the font colour of the word (Robbins & Ehrman, 2005). For example, participants may be shown a word (cocaine) and asked to identify the font colour (red). Individuals with problem experience with cocaine, i.e., heavy use or addiction, show slower response times than those without the problem experience. This is assumed to occur because the drug user pays more attention toward the cue "cocaine" than to the font colour (Robbins & Ehrman, 2005).

Next, the dot-probe task measures whether individuals with experience with drugs or alcohol are slower to respond to an experimental task when a drug or alcohol related cue, i.e., picture, is shown as a distracter (Mogg et al., 2005; Wiers et al., 2006). For example, participants may be shown an alcohol cue and a neutral cue on a computer screen and asked to press a key when a dot appears. Those with alcohol use problems show slower response times than those

without alcohol use problems when the dot appears in the neutral cue. This is assumed to occur because the alcohol users' have an attentional bias to, or are paying attention to, the alcohol cue. Accordingly, those with problem alcohol experience respond quicker when the dot appears in the alcohol cue. It should be noted that these studies are performed when individuals are sober, unless otherwise noted (Mogg et al., 2005; Wiers et al., 2006).

Lastly, eye-tracking is used to measure exactly what individuals are paying attention to in pictures, that is, which specific cues they are paying attention to, and the amount of time spent paying attention to each cue (Balcetus & Dunning, 2006; Mogg et al., 2005; Wadlinger & Isaacowitz, 2008). Attentional bias is measured by comparing the amount of time individuals look at one cue vs. another cue. For example, eye-tracking measures how much time drug users look at drug paraphernalia vs. non-drug related cues. Studies show that individuals with heavy drug use experience look significantly longer at drug paraphernalia or cues than individuals without heavy drug use experience. Pictures are generally shown for 200ms to 10,000ms (see Wiers & Stacy, 2006 for review). While each task can objectively measure what individuals pay attention to, without directly asking individuals what they think they pay attention to, eye-tracking was used in this study. Eye-tracking has shown to be an ecologically valid and directly observable measure of orientation of visual attention (Balcetus & Dunning, 2006; Mogg et al., 2005; Wadlinger & Isaacowitz, 2008; Wiers et al., 2006). With a detailed survey of participants past experiences relating to drugs and alcohol, as well as their feelings towards drug and alcohol use, we will be able to compare individuals experiences with amount of time spent gazing at drug and alcohol cues. Areas within each picture containing drug or alcohol cues are defined as "Lookzones", i.e., specified areas identified by the researcher as containing a drug or alcohol cue. By placing Lookzones around the drug and alcohol cues, the cues are differentiated from



other cues not related to drugs and alcohol. Time spent within the Lookzones is compared to time spent outside of the Lookzones. This research is using eye-tracking as a measure of attentional bias in order to identify bias in attention to more natural drug and alcohol cues in a non-addicted population.

### *Ambiguous Words*

Another indirect measure of cognition is the “ambiguous word task”. Ambiguous words, or homographs, are words that have multiple meanings to one written form, such as *row* a boat and *row* of seats (Ming-Tzu & Nation, 2004). Ambiguous words have been used as an indirect measure of drug and alcohol use behaviour in many studies. Participants are given an ambiguous word and asked to respond with the first word that “pops” to mind. While measuring drugs and alcohol, participants are given a homograph that potentially has drugs or alcohol associated with it. For example, “pot” and “draft” are often chosen as homographs. In North America, “pot” is associated with marijuana, and “draft” is associated with beer. Stacey (1997) suggests that frequency of the behaviour related to the homographs, i.e., heavy drinking and draft (beer), was predictive of their response. The fact that the individual was a heavy drinker predicted their response of beer for the word draft. No other variables were predictive. Normally, these responses are coded as related to drugs or alcohol by coders. However, in our study, to avoid issues surrounding researchers coding participants’ responses, participants were asked to self-code what they meant when they responded to the ambiguous words.

### *Expectancy*

Expectancy in drug and alcohol research is the anticipation of a positive outcome when a substance-related cue is detected (Hermans et al., 2002; Stacy, 1997). Expectancy surrounding drug and alcohol use is developed experientially through positive and negative experiences with

drugs or alcohol. These expectancies can be measured through indirect measures such as behaviour associates. Indirect measures that look at participants' expectancy of outcomes from using drugs and alcohol show that only positive expectancy predicts substance use (Stacy et al., 1990). Positive expectancy, or expecting something good to happen after using a substance (e.g., tobacco) can predict future use, intention to use, and craving (Hermans et al., 2002; Palfai, 2002; Stacy, 1997; Stacy et al., 1990). Expectancies play a role in direction of attention towards stimuli that signify rewarding properties. The role in attentional bias will be discussed next.

### *Attentional Bias*

Attentional bias has been studied extensively in cognitive research and is the main concept measured in this study (e.g., Cox, 1988; Field, Mogg, & Bradley, 2005; Johnson, Woodman, Braun, & Luck 2007; Schoemakers, Wiers, & Field, 2007). Attention is the mechanism that filters through salient stimuli. Stimuli saliency, or how much certain stimuli stand out, is subjective and dependent on the amount and type of experience the individual has with it (Wiers & Stacy, 2006). By using attention as a mechanism, organisms are able to approach stimuli like food and water, and avoid stimuli like excessive heat. Organisms associate cues with different stimuli that signify reward, such as food, or punishment, such as excessive heat (Franken, 2003). Attentional bias is a bias to orient attention to relevant stimuli with which the individual has some form of past experience (Johnson et al., 2007; Wiers & Stacy, 2006). In other words, focus turns to stimuli that stand out to an individual (Franken, 2003; Wiers & Stacy, 2006). When attention is directed to specific stimuli, there is less available cognitive capacity to focus on other stimuli.

To understand what draws individuals to bias their attention to certain things more than others in their environment, past experiences need consideration. It is common knowledge that

past experiences shapes how individuals view the world around them. It influences what they look at, how they perceive what they look at, and what they pay attention to (Calvo & Avero, 2005; Calvo & Lang, 2004; Field et al., 2006). These experiences can be significant, insignificant, positive, negative, neutral, happy, sad, etc. They can also motivate individuals to do, or not do, certain things, depending on the associated outcome of a certain behaviour, or their expectancy of outcomes (Hermans et al., 2002; Stacy et al., 1990). That is, the types of experiences individuals have, whether happy, sad, or neutral, plays a role in what kinds of behaviours they choose, consciously or unconsciously, to partake in (Franken, 2003; Palfai, 2002; Thush et al., 2008). To understand what motivates individuals to do, or not do, certain behaviours currently, we need to understand the types of past experiences they had. As previously stated, understanding motivation behind actions is not a simple task and requires the examination of many variables. One way to understand motivation is to look at past experiences, what types of experiences they were, and what those individuals pay attention to in their environments. This can help explain reasons for attentional bias and provide insight into what motivates individuals to partake in certain behaviours.

Some cues attract more attention than others and individuals become preoccupied with these cues, ignoring other cues. In terms of drug and alcohol addiction, attention is paid most to stimuli that is associated with a desire of drugs or alcohol, typically drug or alcohol stimuli, rather than non-drug related stimuli. Expectancy of a positive outcome plays a role in orienting attention (Field et al., 2006; Hermans et al., 2002; Schoenmakers, Weirs, & Field, 2008). In other words, the drug or alcohol cues “ . . . become especially salient stimuli, stimuli that grab attention, that become especially attractive and wanted, thus eliciting approach and guiding behaviour to the goal” (Robinson & Berridge, 2000, p. 566). There is ample evidence for the

presence of an attentional bias in addiction-related disorders, including alcohol dependence, nicotine dependence, cocaine dependence, and opiate dependence (see Weirs & Stacy, 2006, for a review). Research on attentional bias is important because attentional bias to drug cues may be an important determinant of drug craving as we approach drug related cues and have drug seeking behaviour.

In terms of measuring attentional bias, attention is often measured in two parts: orientation of bias and maintenance of bias (Calvo & Avero, 2005; Calvo & Lang, 2004; Field et al., 2006). Orientation of bias is simply where individuals direct their attention first, typically within 0 s to 2 s. Maintenance of bias is where individuals continue to pay attention after cognitively processing the picture, usually after 2 s; however, sometimes as short as .5 s (Calvo & Avero, 2005; Calvo & Lang, 2004; Field et al., 2006). The orientation of bias and maintenance of bias differ depending on the type of stimuli and the experiences of the individuals. In terms of drug and alcohol abuse, previous research has shown that individuals with substance abuse problems do not necessarily immediately orient their attention to drug or alcohol cues, but cognitively process the picture first, and then maintain their bias on the drug or alcohol cues (e.g., Field, Mogg, & Bradley, 2005; Mogg, Field, & Bradley, 2006; Schoemakers et al., 2007).

The majority of research on attentional bias and substance use has considered only populations with substance addictions (e.g., Field et al., 2005; Field et al., 2006; Gilbert et al., 2007; Schoemakers et al., 2007; Wiers & Stacy, 2006). One limitation to studying attentional in individuals with substance addictions is that even in a well-done, objective study, the results for attentional bias in addicted populations cannot be generalized past addicted populations. Because attentional bias is dependent on experience, results can only be generalized to those with very similar experiences. This study looks at whether these same attentional processes do occur in a

non-addicted population with similar, but less extensive, experiences with drugs and alcohol than addicted populations.

### *Incentive Motivation*

Incentive motivation is the tendency to perform a behaviour that will lead to an anticipated reward (Field et al., 2006; Franken, 2003; Noël et al., 2007; Robinson & Berridge, 2003; Thush et al., 2008). The reward becomes associated with certain behaviours, therefore, creating a memory association between a behaviour or situation and an outcome or reward. In terms of drugs and alcohol, research has shown that when individuals have a memory association between a substance and a positive outcome, the individuals are more motivated to do the drug because of its association with the positive outcome (Franken, 2003; Noël et al., 2007; Robbins & Erhman, 2005; Stacy, 1995). That is, they expect a certain positive outcome to happen, and are more motivated to use the drug. The relation between incentive motivation and attentional bias is the more an individual is motivated to perform a behaviour, such as take a certain drug, the more that individual will pay attention to cues related to that drug, because of the cue's positive association, e.g., a positive experience or biological reward such as dopamine release (Franken, 2003). This is especially strong when individuals expect certain outcomes based on past experiences (Balcetus & Dunning, 2006; Herman et al., 2002; Johnson et al., 2007; Noël et al., 2007; Stacy, 1997; Stacy et al., 1990). Experience, expectancy, and attentional bias interact, resulting in incentive motivation. We predict that these factors are expected to unconsciously, without awareness, influence where participant's eyes move over the pictures.

Incentive motivation explains why those with substance use experience spend longer focusing on, that is, have an attentional bias to, drug and alcohol cues than other cues (Franken, 2003; Noël et al., 2007; Robbins & Ehrman, 2005; Stacy, 1995). It should be noted that research

has shown that attentional bias towards drug and alcohol cues can be related to both positive and negative, or anxiety provoking, experiences with drugs and alcohol (Carlo & Avero, 2005; Calvo & Lang, 2004; Franken, 2003; Robbins & Erhman, 2005; Stacy, 1995). As described above, for incentive motivation to be a driving force behind attentional bias, individuals must hold a positive association between a drug or alcohol experience and the drug or alcohol cue, i.e., expect a positive outcome (Franken, 2003; Robbins & Ehrman, 2005; Stacy, 1995). Otherwise, attentional bias can result from negative or anxiety provoking experiences (Carlo & Avero, 2005; Calvo & Lang, 2004). To ensure incentive motivation is the driving force behind measured attentional biases, this study gathered detailed information about participants' subjective feelings towards their experiences with drugs and alcohol.

#### *Addiction and Incentive Motivation*

To understand substance use, it is important to understand substance abuse. Briefly, there are two main theories on how addiction is maintained that have been developed through research (Franken, 2003; Noël et al., 2007; Robinson & Berridge, 1993; Robinson & Berridge, 2003). First, addiction is maintained via classical conditioning through which the drug and drug-related cues develop positive incentive properties. That is, drug related cues become associated with positive reinforcing properties of the drug. In general terms, the drug-related cues gain conditioned incentive properties. The individual is then drawn to the drug by the conditioned incentive properties, leading to incentive motivation for the individual to take the drug (Franken, 2003; Noël et al., 2007; Robinson & Berridge, 1993; Robinson & Berridge, 2003).

Second, addiction is maintained via biological functions (Robinson & Berridge, 1993; Robinson & Berridge, 2003). The individual repeatedly takes the drug, which sensitizes the nucleus accumbens and related circuitry in the mesolimbic dopamine system. Each time the drug

is taken, the amount of dopamine released in the nucleus accumbens increases in magnitude. The incentive value of the drug and pathological motivation for taking the drug progressively increases (Robinson & Berridge, 1993; Robinson & Berridge, 2003). In other words, in behavioural terms, this means that a drug cues acts as a powerful conditioned incentive that “grabs attention, becomes attractive and ‘wanted’ and thus guides behaviour to the incentive” (Robinson & Berridge, 1993, p. 261). The hypotheses surrounding attentional bias in this study were derived from theories on maintenance of addiction. The current study is sampling a population with a wide variety of drug and alcohol experiences to measure whether cognitive processes, such as attentional bias, that occurs in an addicted population also occurs in a non-addicted population. Applying the incentive motivation theory of addiction to this study, the current study looks to better understand drug use behaviour in a non-addicted population by learning about non-addicted drug users positive associations with drug experiences.

### *Hypotheses*

1. Participants’ results of drug and alcohol recency and frequency of use will replicate similar samples of university populations.
2. This new measure of attentional bias will predict the recency and frequency of substance use. That is, participants with more frequent and current marijuana or alcohol use will spend more time in Lookzones associated with marijuana or alcohol stimuli compared to participants with less frequent and current use, due to stronger incentive motivation.
3. The present study will replicate results for other indirect measures of substance use associations. That is, participants who have used drug and alcohol more frequently in the past year will produce more alcohol or drug responses to ambiguous words (homographs)

and behavioural associates than participants with less frequent drug and alcohol use in the past year, due to stronger substance use memory associations

4. Attentional bias will be positively correlated with the other indirect measures i.e., ambiguous words and behaviour associates tasks, and predict unique variance in substance use.
5. The strongest cognitive correlation with Lookzone times will be the behavioural associate score as this is most indicative of incentive motivation.

## Method

### *Participants*

Participants were 72 university from the University of British Columbia Okanagan and 8 college students from Okanagan College in Kelowna BC, Canada. The participants were required to have English as their first language and normal vision or corrected normal vision. The median age of participants was 20.3 years and the range was 18-30 years. The majority of the participants were female (77.2%). Incentives were offered for participation. Psychology undergraduate students received one bonus percent in a psychology course of their choice assigned through an online tool. Participants not attending the university received a \$10 gift card to a local restaurant. The Behavioural Research Ethics Board of the University of British Columbia approved all procedures used in this study.

### *Materials and Apparatus*

There were 9 tasks in the experiment presented in the following order: Eye-tracking, ambiguous words, behaviour associates, expectancy-likability, activities questionnaire, Substance use risk profile scale+ (SURPS+), CRAFFT (acronym for Car-Relax-Alone-Friends-Forget-Trouble), Drug abuse screening test (DAST), and demographics. All measures were



obtained in a small and specially equipped testing room with external sound and light isolation. For the eye-tracking task, a series of pictures were viewed on Cambridge Systems Video Eyetracker Toolbox running on a Pentium 4 desktop with Windows XP Professional Version 2002 Service Pack 2. A Dell 2407WFPb was used that could be rotated 90 degrees to present both vertical and horizontal formats with minimal loss of full-screen capacity for the participants. A Samsung SyncMaster 213T was used by the researcher. The remaining tasks were completed on Inquisit 3.0™, a software system used to provide both standard survey questions and cognitive tasks with precise millisecond timing, using a standard computer, keyboard, and mouse.

*Eye-tracking pictures.* Participants viewed a series of either 28 or 34 pictures. One set of pictures was counter balanced and used for all participants. Thirty participants received four fewer neutral pictures and 10 additional drug and alcohol pictures after the original set was shown. The original set of pictures included a variety of historical art pictures (17), anti-aesthetic art (3), and film and real-life still shots of social scenes (8) (see [Appendix A](#) for a sample of eye-tracked pictures). There were 7 historical art paintings displaying alcohol cues, 1 historical art painting displaying a marijuana cue, 1 film still-shot with an alcohol cue, 1 real-life picture with an alcohol cue, and 1 real-life picture with a drug cue. Pictures were accumulated based on their inclusion or exclusion of alcohol or drug cues. The pictures were counter-balanced.

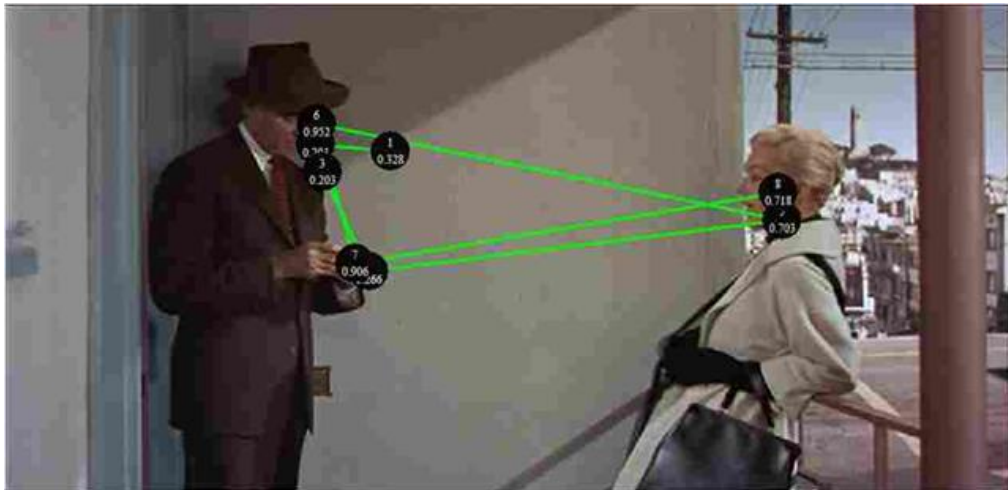
The additional pictures, seen only by 30 of the participants, were counterbalanced and shown after the other pictures. These pictures portrayed five nearly identical social scenes displaying young adults with either alcoholic beverages or non-alcoholic beverages or drug and drug paraphernalia or food in identical places<sup>1</sup>. For example, one scene consisted of a female and

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<sup>1</sup> Thank you to Kris Anderson for graciously providing us with pictures she designed to use in our study.

a male young adult in kitchen holding out a pipe. Another scene was nearly identical but a bag of chips replaced the pipe.

Lookzones were established in areas of interest for each picture. Lookzones are specified areas that can be compared against the rest of the picture. Below are pictures used in the study: Figure A is a neutral film still shot with eye-tracking, Figure B is the marijuana cue painting, Figure C is a neutral painting, and Figure D is an alcohol cue painting.



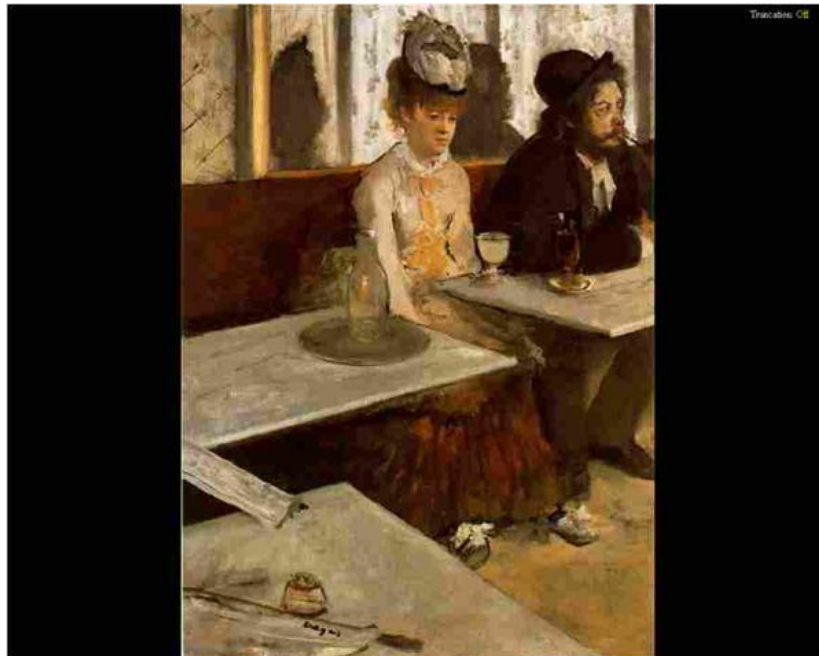
*Figure A.* Neutral film still-shot



*Figure B.* Marijuana cue painting



*Figure C.* Neutral painting



*Figure D.* Alcohol painting

The remaining tasks were completed on Inquisit 3.0. A battery of tests measured memory associations and determined the frequency, recency, and likeability of behaviours participants

have engaged in. The three indirect memory association measures used were: ambiguous word associations, situation-behaviour associates, and emotion-behaviour associates. These were presented in the form of a fill in the blank, open-ended free association task.

*Ambiguous word associations.* The ambiguous word association task used homographs, that is, words that have multiple meanings to one written form, such as *row* a boat and *row* of seats, to measure memory associations for drug and alcohol use indirectly and possibly without awareness (Ming-Tzu & Nation, 2004; Stacy, 1997). The 32 ambiguous words were chosen similar to Stacey (1997) and used previously with this population. Nine marijuana ambiguous words, six alcohol ambiguous words, and six control ambiguous words were given (see [Appendix B](#)).

*Behaviour associates.* There were two different types of behaviour associates. In the situation-behaviour associate task the probe was common situation, such as “a typical Friday or Saturday night” that might be linked to alcohol or drug use. Respondents provided a behaviour that they associate with the situation (Stacy, 1997). A typical alcohol response from a drinker would be “getting drunk.” In the emotion-behaviour associates task the probe was an emotion such as “feeling dreamy.” These phrases are feelings that previous testing has shown to be associated as an outcome of drug or alcohol use (Stacy, 1997). Respondents were asked to write the first behaviour or action that came to mind when they saw the emotion phrase. A typical response from a marijuana user might be “getting high” (Stacy, 1997). Eight emotion-behaviour associates were shown. Six neutral control-behaviour associates and two neutral practice-behaviour associates were also given for a total of 25 associates shown (see [Appendix C](#)). After the first two practice associates, all other phrases were shown in random order.

*Activity questionnaire.* An extensive activity questionnaire asked participants about the recency, frequency, duration, and likeability of their general behaviours in areas of: drugs, alcohol, violence (physical bullying, relational aggression, dating violence), exercise, time spent socializing with family and friends, and miscellaneous areas such as their involvement in church activities (see [Appendix D](#)). Conditional questions were asked based on responses to the drug and alcohol use questions, i.e., further questioning occurred about frequency, duration, and likeability of using alcohol or marijuana if participants answered that they had used alcohol or marijuana. These questions were based on previous surveys with this population.

*Substance use risk profile scale+.* The SURPS is a 23-item questionnaire that identifies levels of personality and environmental risk factors for using substances: anxiety seeking, hopelessness, sensation seeking, and impulsivity (Krank et al., submitted). Twelve similarly structured items that asked about violence exposure and neglect were added in this version, SURPS+. Participants rated their degree of agreement or disagreement on a 5-point likert scale (see [Appendix E](#)). Each of the six factors in the measure independently predicts vulnerability to substance abuse in previous studies with this population.

*Problem alcohol and drug use measures.* The CRAFFT is a validated 6-item questionnaire that identifies problem alcohol and substance use in adolescents and young adults by asking direct questions about problem behaviour when using substances (Knight, Sherritt, Harris, Gates, & Change, 2003). A score of 2 positive responses or more identifies a need for further assessment (see [Appendix F](#) for questions). The DAST is a validated 10-item questionnaire targeted at adults to identify drug use problem behaviours (Yudko, Lozhkina, & Fouts, 2007). A score of 3 or more identifies a need for further assessment (see [Appendix G](#) for questions).

*Demographics.* A basic demographics questionnaire identified the variables: age, gender, year in program, marital status, and religion (see [Appendix H](#)).

### *Procedures*

The experiment began with the eye-tracking task, followed by the ambiguous word associates task, behaviour-associates task, expectancy-likeability tasks, activity questionnaire, SURPS+, CRAFFT, DAST, and finally, demographics. All pictures in the eye-tracking task were counterbalanced. The eye-tracking task was presented first because we did not want to prime participants with cues from the survey that could bias their viewing of the pictures. Further, to avoid priming for the word association tasks, we presented the ambiguous words and behaviour associates immediately after the picture viewing. The order of tasks remained the same for each participant, but the questions and phrases within each task were randomized with the exception of the CRAFFT, DAST, demographics questionnaire, and specific sections of the activities questionnaire (see below for details).

To begin the experiment, participants were greeted by the experimenter outside of the research lab and directed into the research room. Sessions were run individually and took place in a small testing room that held a computer and the eye-tracking apparatus. First, the participant was informed about the process and of the sensitive parts of the study. Specifically, they were told that the pictures contained historical art, some of which contained nudity. They were also informed that there were questions about drug and alcohol use within the questionnaire. Next, the participants were asked to read through and sign the consent form if they wished to participate (see [Appendix I](#)). Upon completion, the researcher instructed the participants to sit in the height adjustable chair and the researcher adjusted the eye-tracker chin rest to the appropriate height. The participants were seated 57 cm from the screen and instructed to stay as still as possible for

the duration of the eye-tracking task, but they could blink. The researcher told the participant that the lights would be dimmed and then dimmed the lights.

*Eye-tracking measurement.* The eye-tracking machine was calibrated for each participant by having participants follow a small black circle at 20 different black points on a grey screen. After calibration, the researcher began the eye-tracking task and the participants viewed a black screen for 3 s, and then began viewing the set of pictures. The inter-trial intervals were 7.5 s with a black slide with a fixation point for 2.5 s, in between each picture slide (Labar, 2000). Each picture remained on the display for 5 s.

*Inquisit testing.* Following the eye-tracking task, the researcher turned on the light and told the participant that the first portion of the experiment was complete and that the participant was to move to the researcher's computer to complete the remaining tasks. The researcher instructed the participants that they were to complete all the tasks as directed on screen and then retrieve the researcher when they were complete. The researcher then left room. Each of the eight tasks had clear instructions on how participants were to proceed. In between each task, the program instructed participants to press a key before moving on to the next task. The first three tasks were the ambiguous words, situation-behaviour associates, and emotion-behaviour associates, respectively. Each task instructed the participants to type the first word that "pops" to mind when a word or phrase is shown on the screen. Only one word or phrase, depending on the task, was displayed on the screen at a time. The order of tasks was fixed, but the words or phrases within each were randomized. Each free associate task gave participants two practice probes prior to commencing the measured probes.

*Self-coding.* After each free associate task was completed, participants were asked to code what each response referred to. Coding options were: alcohol, marijuana, other drugs,

recreation, relaxing, romantic relationships, and friendships. The participants were shown each of their responses again in the context of the probe item and chose any and all option(s) that applied to their responses. This novel approach was done to avoid issues surrounding researcher coding ambiguous words (Frigon & Krank, submitted).

*Survey questions.* For the activity questionnaire, participants were instructed to provide their best answer for each question, and to respond “zero” or “no” if they had not performed an activity within the timeline indicated by the question. Some questions were conditional and further questions were asked only if participants had responded yes to having ever done the activity (e.g., drank alcohol or used marijuana). First, recency questions about drug and alcohol use, exercise, entertainment, and socializing were asked. Next, frequency of behaviours about alcohol and marijuana use, exercise, entertainment and socializing were asked. Quantity of alcohol and marijuana consumption, and number of hours per day in the past 30 days of performing a behaviour, i.e., alcohol and marijuana use, exercise, entertainment and socializing, were asked about next. Lastly, two miscellaneous questions were asked. The entertainment and socializing questions were randomized and shown individually on screen. The other questions were fixed.

After completion of the activity questionnaire, participants completed the SURPS+. The SURPS+ items were randomized, with one question appearing on the screen at a time. Each question was rated on agreement or disagreement on a 5-point likert scale. Next, participants completed the CRAFFT and the DAST. In the CRAFFT, all 6 items were display onscreen, and items in the DAST were shown in two segments. Finally, the participants completed the demographics questionnaire. When this task was complete, the participants retrieved the



researcher, whom debriefed participants about the nature of the study (see [Appendix J](#) for debriefing form).

### Results

All data was compiled in and analyzed using SPSS 15.0 with an alpha level of .05. All dependent measures were assessed for violations of normality. Frequency measures were, as expected, not normally distributed and positively skewed. The statistics reported here are for untransformed measures; however, where required, these count measures were also analysed using the natural log transformation to reduce skew. All conclusions based on the original data were confirmed using these transformed variables.

#### *Alcohol and Marijuana Use Recency and Frequency*

The alcohol and marijuana use by the sample showed substantial variability (Table 1). Most of the sample had drunk alcohol in the past year 89.1% and almost half (49.4%) had drunk alcohol in the past week. More than half of the sample had smoked marijuana in their lifetime, but more recent use was less likely, with less than one in ten having smoked in the past week and 22.4% having smoked marijuana in the past month. The mean number of days used in the past month was 5.1 (SD = 5.0) for alcohol and 1.8 (SD = 5.6) for marijuana.

Table 1.

#### *Recency and Frequency of Alcohol and Marijuana Use*

|                           | Never | More than 1<br>year ago | Past year | Past month | Past week |
|---------------------------|-------|-------------------------|-----------|------------|-----------|
| Most recent alcohol use   | 10.1  | 0                       | 2.5       | 38         | 49.4      |
| Most recent marijuana use | 49.4  | 10.1                    | 17.7      | 13.9       | 8.5       |

### *Problem Substance Use*

Individual problem drug and alcohol use was also measured. Problem use was measured using the CRAFFT and the DAST. The CRAFFT is a 6-item questionnaire assessing adolescent problem alcohol use behaviours, such as riding in a car with an intoxicated driver (see [Appendix E](#) for questions). The DAST is a 12-item questionnaire assessing substance use problem behaviours in adults, such as family and career problems (see [Appendix G](#) for questions). For the CRAFFT ( $M = 2.08$ ,  $SD = 1.59$ ), 57.5% of participants reported a score of 2 or more, indicating problem use of drugs and alcohol. For the DAST ( $M = 1.30$ ,  $SD = 1.27$ ), 17.9 % of participants reported a score of 3 or higher, indicating problem behaviours with drug use.

### *Measurement of Attentional Bias*

Attentional bias was measured by examining the duration of gaze time directed at the relevant object in the picture. For each picture, a Lookzone was established. Each Lookzone was a straight-edged box that enclosed the drug or alcohol cue. The Lookzones were large enough to encompass the entire cue, but did not include any other significant stimuli. The researcher determined the Lookzone size and ensured no other significant or potentially distracting stimuli was within close proximity to the Lookzone. For drug and alcohol related pictures, Lookzones were created in a box around the cue (e.g., beer bottle, wine glass, liquor bottle). The “Lookzone times”, or the amount of the total viewing time the participant’s gaze was in the Lookzone was used to index attentional bias (see [Figure E](#) and [Figure F](#) for example eye-tracked pictures). For the purposes of these analyses, the total time looking at alcohol cues in all art pictures was calculated by summing the scores of individual pictures. For marijuana, only one picture was included (see [Figure E](#)). Over the entire sample, alcohol cue Lookzone times and drug cue

Lookzone times were used as the index of attentional bias (Table 2). The alcohol cues times score was significantly correlated with the marijuana cue time,  $r(80) = .322, p < .01$ .

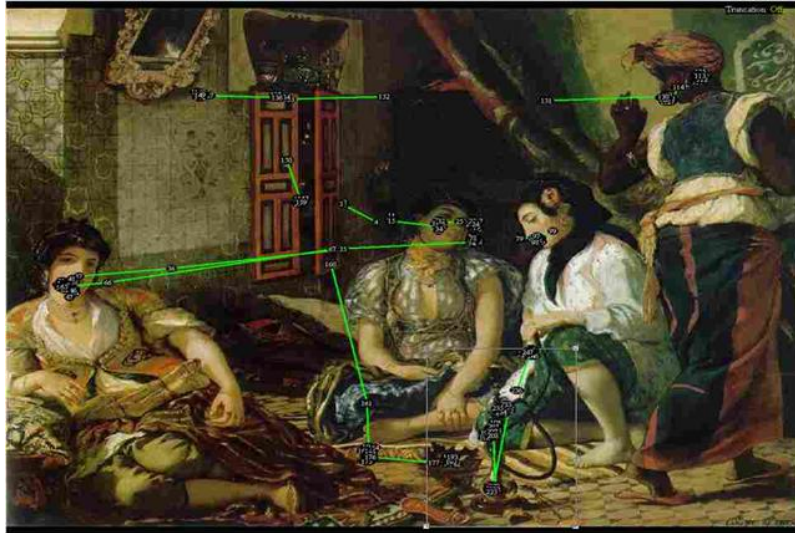


Figure E. Eye-tracked picture of heavy marijuana user focusing on drug paraphernalia.



Figure F. Eye-tracked picture of heavy alcohol user focusing on alcohol cue.

Table 2.

*Attentional Bias and Time Spent in Lookzones*

|              | Mean | Standard<br>Deviation | Median |
|--------------|------|-----------------------|--------|
| Alcohol cues | 1.69 | 1.10                  | 1.87   |
| Drug cue     | .05  | .10                   | .00    |

*Attentional bias and alcohol and marijuana use and problems*

The Pearson Product Moment correlations between the frequency of alcohol and marijuana use in the past 30 days, the recency of marijuana use, the CRAFFT score, and the DAST score with the amount of time spent looking at alcohol cues or the marijuana cue are shown in Table 3. A significant relationship was found between frequency of alcohol use and the time looking at alcohol cues,  $r(80) = .36, p < .05$ , frequency of marijuana use and the time looking at drug cues,  $r(80) = .48, p < .001$ , and frequency of marijuana use and time at alcohol cues,  $r(80) = .26, p < .05$ . Problem use was also associated with attentional bias to alcohol cues.

Table 3.

*Correlations Between Alcohol and Drug Cue Lookzone Times and Use and Problem Use*

|                     | Alcohol cues | Marijuana cue |
|---------------------|--------------|---------------|
| Alcohol Frequency   | .355**       | .124          |
| Marijuana Frequency | .259**       | .483**        |
| Alcohol Use         | .199         | .222          |
| Marijuana Use       | .320**       | .348          |
| CRAFFT              | .26*         | .10           |

|      |     |     |
|------|-----|-----|
| DAST | .11 | .19 |
|------|-----|-----|

---

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

*Ambiguous Word Associations and Alcohol and Marijuana Use*

Linear regression was conducted to determine the prediction of frequency of alcohol use from alcohol ambiguous words and frequency of marijuana use from marijuana ambiguous words. The regression analysis shows that only marijuana ambiguous words were a significant predictor of frequency of marijuana use ( $\beta = .61, p < .001$ ), with 37% of the variance accounted for in frequency of marijuana use. Alcohol ambiguous words were not a significant predictor of frequency of alcohol use ( $\beta = .20, p > .05$ ), with 4% of the variance accounted for in frequency of alcohol use.

*Behaviour Associates and Alcohol and Marijuana Use*

Linear regression was performed to assess the prediction of frequency of alcohol use from alcohol emotion-behaviour associates and alcohol situation-behaviour associates. The regression analysis showed that alcohol emotion-behaviour associates were a significant predictor of frequency of alcohol use ( $\beta = .57, p < .001$ ), with 33% of the variance accounted for in frequency of alcohol use. Also, alcohol situation-behaviour associates were a significant predictor of frequency of alcohol use ( $\beta = .64, p < .001$ ), with 41% of the variance accounted for in frequency of alcohol use.

Again, linear regression was computed to assess the prediction of frequency of marijuana use from marijuana emotion-behaviour associates and marijuana situation-behaviour associates. The regression analysis showed that alcohol outcome-behaviour associates were a significant predictor of frequency of marijuana use ( $\beta = .67, p < .001$ ), with 44% of the variance accounted for in frequency of marijuana use. Also, marijuana situation-behaviour associates were a

significant predictor of frequency of marijuana use ( $\beta = .65, p < .001$ ), with 42% of the variance accounted for in frequency of marijuana use.

*Relative Prediction of Alcohol and Marijuana Use by Attentional Bias and Other Indirect Measures*

Next, we tested the relationship of the attentional bias scores with behavioural associates, both emotions and situations, and with ambiguous words. Attentional bias measures correlated with the other indirect measures of association with alcohol and marijuana. The pattern of results, however, was different for marijuana and alcohol (Table 4). As we hypothesized, the alcohol attentional bias score correlated more strongly with the behavioural associates and less so with ambiguous words. Marijuana attentional bias, however, correlated more strongly with the ambiguous words and, indeed, was only significant for the situational associates.

Table 4.

*Correlation of Attentional Bias Scores with Other Indirect Measures*

|               | Emotion associates | Situation associates | Ambiguous words |
|---------------|--------------------|----------------------|-----------------|
| Alcohol cues  | .349**             | .435**               | .272*           |
| Marijuana cue | .139               | .284*                | .341**          |

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

A sequential multiple regression analysis was performed to test the unique prediction of alcohol and marijuana use by attentional bias compared to other indirect measure of alcohol and marijuana association. The first model used only the attentional bias score. The second model added ambiguous word associates and the two behavioural associate measures. The second model was tested to see determine whether 1) the other indirect measure improved the model over attentional bias and 2) attentional bias had unique predictive value. As seen in Table 5,

Model one showed that alcohol attentional bias predicted alcohol frequency (11.7% of variance), but not use. Marijuana attentional bias predicted both marijuana use (12.2% of variance) and frequency (26.5% of variance). Model two, adding the other indirect measures of association, improved the predictive value for each measure with the model accounting for 29% of the variance in alcohol use, 50% of the variance in alcohol frequency, 56.5% of the variance in marijuana use, and 68.4% of the variance in marijuana frequency.

Table 5.

*Prediction of Recency and Frequency of Use from Attentional Bias*

|                  | Alcohol              |                      | Marijuana            |                      |
|------------------|----------------------|----------------------|----------------------|----------------------|
|                  | Use                  | Frequency            | Use                  | Frequency            |
|                  | R <sup>2</sup> /beta | R <sup>2</sup> /beta | R <sup>2</sup> /beta | R <sup>2</sup> /beta |
| Model 1          | .031                 | .117**               | .122**               | .265***              |
| Attentional bias | .177                 | .342**               | .349**               | .514***              |
| Model 2          | .290***              | .500***              | .565***              | .684***              |
| Attentional bias | .067                 | .070                 | .142                 | .307***              |
| Ambiguous word   | .241*                | -.007                | .419***              | .206**               |

|           |        |         |       |       |
|-----------|--------|---------|-------|-------|
| Emotion   | -.087  | .243    | .374* | .339* |
| Situation | .503** | .497*** | .029  | .178  |

---

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

In predicting alcohol use, only ambiguous word associations and situation – behaviour associates remained significant. For alcohol frequency, only situation – behaviour associates remained significant. Marijuana use revealed a slightly different pattern with ambiguous word associates and emotion – behaviour associates as significant components of the model.

Attentional bias effects were not unique for any of these three measures; however, a different picture emerges for marijuana frequency. Ambiguous word associates, emotion – behaviour associates, and attentional bias predicted marijuana frequency of use over the past 30 days. This observation not only indicates unique predictive value for the marijuana attentional bias, but also contributes, along with the other indirect measures, to a very strong model predicting a high level of variance in number of days using marijuana.

## Discussion

### *Main Findings*

Cognitive measures are very important in predicting substance use. These measures have been successful in that they indirectly measure memory associations of substance use. It is useful to use indirect measures when studying behaviours such as drug and alcohol use since much of behaviour is governed by unconscious influences (Charash et al., 2006; Cox, 1988; Robbins & Ehrman, 2005; Schoenmakers et al., 2007; Thush et al., 2008; Wiers et al. 2006). In other words, often, individuals cannot explain exactly why they do certain behaviours or the associations they have between a cue and the actual drug or alcohol use (Stacy, 1995). Often, behaviour is irrational in the sense that action can be strongly influenced by memories that the individual is



not aware of at the time of action or choice. For this reason, researchers should indirectly assess associations between drugs and alcohol to better understand associative influences on substance use behaviour.

This study replicated previous findings showing that indirect measures of substance use memory associations predict substance use (Stacy 1995; Stacy, 1997). Our key finding however, was that the new eye-tracking measure of attentional bias predicted alcohol and marijuana use similar to other validated indirect measures, such as the ambiguous words and behaviour associates. The new measure is particularly interesting because the method is likely implicit, i.e. without awareness, and closely parallels findings of attentional bias where the association is established by experimental protocols in the laboratory. Specifically, experimental studies of incentive motivation train visual associations with substance use. Visual cues associated with drinking alcohol, for example, demonstrate not only attentional bias, but also approach, seeking, and increased substance use (Krank, 2003; Krank et al., 2008). This parallel supports an incentive motivation interpretation of the individual differences in marijuana and alcohol use.

Our new indirect measure looks at a cognitive measure of appetitive association, i.e., attentional bias, in individuals who have used drugs and alcohol and, thus, developed associations between alcohol and drugs cues and certain outcomes. The theory of incentive motivation explains drug and alcohol use based on positive outcome associations. That is, when individuals have increased experience with drugs and alcohol, they develop associations between drug and alcohol cues and positive outcomes from using drugs and alcohol (Hermans et al., 2002; Schoenmakers et al., 2007; Stacy, 1995; Stacy, 1997). Incentive motivation draws attention to drug and alcohol cues because of the learned association (Krank, 2003; 2008) and, consequently, they spend more time looking at these cues (Schoemakers et al., 2007).

*Alcohol and Marijuana Use*

The participants' recency and frequency of alcohol and marijuana use, and problematic use was similar to other university-aged samples in Canada (Flight, 2006), suggesting that the method of measurement was valid. Problem use, indicated by the CRAFFT and the DAST, was also similar to other university-aged samples (Knight et al., 2003; Yudko et al., 2007).

*Attentional Bias and Alcohol and Marijuana Use*

The study found that as frequency of alcohol and marijuana in the past 30 days increased, time spent looking at alcohol and marijuana cues increased, respectively. These findings are similar to findings in samples of individuals with substance addictions (Field et al., 2005; Field et al., 2006; Schoemakers et al., 2007). In these past studies, the participants with substance use problems spent longer looking at drug and alcohol cues than other aspects of the pictures. In this study using a non-clinical population, individuals who used marijuana and alcohol more often looked at drug and alcohol cues longer than those who did not use marijuana and alcohol as often. The theory of incentive motivation holds that when users have a positive association with the drug or alcohol, the more they will pay attention to it because they are anticipating a good outcome (Franken, 2003; Krank, 2003; Krank, 2007). Our research replicates other studies of attentional bias by showing that the more participants have used drugs and alcohol, the more they pay attention to a cue that signifies drugs and alcohol (Field et al., 2006; Gilbert et al., 2007; Schoemakers et al., 2007).

The present method of measuring attentional bias is likely to measure implicit memories. In particular, the study used materials from film and art that were not evidently about marijuana and alcohol use. In addition, the study merely informed participants that the researcher was interested in how they processed visual scenes. This study measured attentional bias via eye-

tracking before asking participants about their substance experiences. All of these factors favour an implicit memory interpretation of the attentional bias measure used here.

Time spent looking at the alcohol and marijuana cues predicted alcohol and marijuana use, respectively. Past studies using indirect alcohol and marijuana measures, such as ambiguous word associates, also predict alcohol and marijuana use (Stacy, 1995; Stacy 1997). These studies have been replicated in university-aged populations and consistently show that the more alcohol or marijuana words participants respond with, the more frequently they use alcohol or marijuana, respectively. Our new measure of attentional bias provides results similar to other indirect measures.

Attentional bias towards alcohol cues also predicted problems with alcohol and drug use, measured with the CRAFFT. The more an individual reported problems with drugs and alcohol, the longer they spent looking at alcohol cues. This falls in line with previous research on substance abuse showing stronger attentional bias in substance abusers than non-problem users (Field et al., 2005; Field et al., 2006; Gilbert et al., 2007; Schoemakers et al., 2007). However, the DAST was not predictive of Looktimes for either marijuana or alcohol. This result likely occurred because the DAST measures mainly illicit drug, and not alcohol, problem use (Yudko et al., 2007). Although the DAST should pick up marijuana problems, the level of marijuana use in the sample was not high enough to produce problem scores in most users. It could be that the attentional bias measure would also discriminate heavier problem users from more casual users, but this sample does not provide a test of that hypothesis.

#### *Indirect Measures and Alcohol and Marijuana Use*

The findings in this study replicated results from Stacy (1995; 1997) in that marijuana ambiguous word associates can predict the frequency of marijuana use in the past 30 days. As

stated previously, the ambiguous words task measures free associates (Stacy, 1995). Ambiguous words are shown and participants are asked to write the first word that “pops to mind”, without knowledge that this experiment is measuring drug and alcohol use. In other words, the participants need to generate their own responses, likely accessing long-term memory for content (Stacy, 1995). While this is an indirect measure, it is also considered implicit because it appears to measure underlying motivation processes without awareness (Robbins & Ehrman, 2005; Thush et al., 2008).

Results from the situation-behaviour and emotion-behaviour associates were also replicated from previous studies (Stacy 1995; Stacy, 1997). The behaviour associates measures predict the frequency of alcohol and marijuana use by asking participants to make their own association, similar to the ambiguous words task, which is likely tapping into long-term memory (Stacy, 1997; Thush et al., 2008).

This study also replicates a new method of coding substance use associates (Frigon & Krank, submitted; Krank et al., submitted). This new method avoids problems with ambiguous responses, such as party, which may or may not be alcohol or marijuana related. In this self-coding task, participants were asked to identify whether their responses were related to marijuana or alcohol later in the session. A number of other descriptors were included such as family, socializing, friends, relaxing, etc. Participants were instructed to choose all that apply. The method allows indirect generation of responses before the self-coding. Research has shown that this method not only captures the response that coders would identify, but it also adds responses that could not clearly be identified. This method ensures more accuracy in assigning response words or phrases to the alcohol and marijuana categories. Most importantly, self-coded measures

of substance use association are better predictors of substance use than researchers coded measures (Frigon & Krank, submitted; Krank et al., submitted).

#### *Attentional Bias and Indirect Measures*

The eye-tracking measure was a good predictor of frequency of marijuana and alcohol use. These measures were also correlated with the other indirect measures. In hierarchical regression analysis of alcohol frequency, however, attentional bias did not account for any independent variance in the prediction of frequency when the other indirect measures were added to the model. This finding actually supports an incentive motivation interpretation. As we predicted, alcohol attentional bias was most strongly correlated with the behavioural associates scores. This is encouraging in that our novel eye-tracking measure accounts for similar variance in alcohol use as other indirect measures of incentive motivation. The analysis of marijuana cognitions did not show the same pattern, but this may be because we used only one picture for the attentional bias measure or because of the pattern of marijuana use. Future research will be required to identify the source of the difference.

These findings are also encouraging because previous eye-tracking studies measured attentional bias to drug and alcohol cues with addicted populations. This study found attentional bias in participants from the general university population. In addition, this research used naturalistic pictures and measurement methods designed to reduce awareness of specific substance use memories. To our knowledge, no previous research has examined the relationship between marijuana use and eye-tracking measures of attentional bias. An interesting finding in this study is that participants who used marijuana more frequently looked longer at the drug cue in the naturalistic picture. Attentional bias from marijuana use in naturalistic pictures, i.e.,

paintings, has not been researched previously. This finding is interesting, although limited, as there was only one picture that was effective in portraying a drug cue.

Based on the findings, eye-tracking of alcohol and drug cues in naturalistic pictures may be a useful measure of attentional bias in a general population. This observation makes sense given that any experience with alcohol or drug use should add to substance use memory associations. Our study measured these memory associations and their relationship to past experiences. Substance users become familiar with the cue, such as drug paraphernalia, in order to use it, and obtain memories between the use and the cue (Stacy, 1995). The more often these cues are used, i.e., drug paraphernalia, the stronger the memory association is. Stacy (1995) explained that “memory associations regarding features of drug use should be predictive of drug use, even if these features are restricted to physical or verbal cues rather than outcomes linked to drug use” (p. 184). Eye-tracking of specific cues works as an effective indirect measure because individuals pay attention to what they have experience with (Balcetus & Dunning, 2006; Mogg et al., 2005; Wadlinger & Isaacowitz, 2008; Wiers et al., 2006). Incentive theories of substance use assume that the interaction with the drug imprints a positive memory on the individuals mind (as cited in Stacy, 1995: consistent with Baker, Morse, & Sherman, 1987; Di Chiara & Imperato, 1985; Gray, 1982; Stacy, 1994; Stewart, de Wit, & Eikelboom, 1984; Wise, 1988). Attentional bias is a potential marker for individual incentive generated by alcohol or marijuana cues. Incentive cues are important to substance use because they draw attention. Moreover, such incentive cues initiate action including approach, contact, and drug seeking (Krank, 2007).

#### *Future Research*

This research was exploratory in that it compared attentional bias in naturalistic paintings and still-shots of real life situations and films in a general student population of emerging adults.

As only one painting showed significant effects in predicting marijuana use, future research should be conducted to determine other paintings and naturalistic pictures that elicit attention of frequent marijuana users. Given the effectiveness of this measure, it would be interesting to see if similar results would be obtained in a younger sample with even more varied substance use patterns.

### *Limitations*

This study used paintings and pictures that have not been previously tested. Therefore, we cannot yet determine the cross-validity of these pictures. However, there were significant correlations between time spent looking at drug and alcohol cues and frequency of drug and alcohol use, indicating that there was a significant relationship between the two factors. Also, many eye-tracking studies pair pictures with small differences and measure whether or not the participants' focus on the differences. This study did not measure pair pictures. The reason for this was to measure whether or not participants generally spend more time looking at cues they have incentive to look at, i.e., drug and alcohol cues, because of previous positive associations with outcomes resulting from using drugs or alcohol, and not whether they notice differences in cues in the pictures. Lastly, females made up the majority of the sample, which may impact generalization to males.

### Conclusion

Incentive motivation has been a popular area of study for substance use researchers. Attentional bias can help clarify the relationship between memory associations and substance use. An important finding from this study is that individuals who have used more alcohol or marijuana, but who are not substance abusers, also have stronger attentional bias towards drug and alcohol cues. This is promising because it indicates that memory associations are strong

enough to elicit attention, and potentially index motivation to use. Cue based incentive motivation is important in understanding approach behaviours, since cues that elicit attention are often cues that elicit approach and seeking behaviours (Krank, 2008; Palfai, 2002; Stacy, 1997). Clarifying the underlying motivations to use drugs by understanding attentional bias, memory associations, and incentive motivation may be useful in developing new more effective intervention for prevention and treatment of substance abuse. Hopefully, researchers will one day be able to find new ways of preventing problematic substance use in all populations.



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Appendix A

Eye-tracker pictures





## Appendix B

*Homograph Word List*

| Marijuana<br>Homographs | Alcohol Homographs | Control homographs |
|-------------------------|--------------------|--------------------|
| bud                     | mug                | control            |
| weed                    | Bottle             | trap               |
| roach                   | cooler             | scrap              |
| blow                    | draft              | date               |
| pot                     | ice                | fling              |
| blunt                   | shot               | hot                |
| hit                     |                    |                    |
| joint                   |                    |                    |
| pipe                    |                    |                    |

## Appendix C

*Behavioural Associates Phrase List*

| Outcome Behaviour<br>associates | Situation behaviour<br>associates     | Control behaviour<br>associates | Practice behaviour<br>associates |
|---------------------------------|---------------------------------------|---------------------------------|----------------------------------|
| feeling good                    | hanging out with<br>friends           | being peaceful                  | getting money                    |
| feeling dreamy                  | going to a party                      | being tolerant                  | getting stronger                 |
| feeling relaxed                 | after school                          | pleasing family                 |                                  |
| having fun                      | at home without<br>parents            | being successful                |                                  |
| forgetting problems             | going to the mall                     | being attentive                 |                                  |
| being more sociable             | staying out really<br>late            | showing respect                 |                                  |
| laughing                        | a typical Friday or<br>Saturday night | being peaceful                  |                                  |



## Appendix D

## Activity Questionnaire

*Recency of behaviour**Substance Use*

Have you ever:

1. Used caffeine
2. Used tobacco
3. Drank alcohol
4. Used over the counter drugs
5. Used prescription drugs
6. Used marijuana
7. Used other illicit drugs

If yes to 7, then which of the following:

- Opiates (heroin, morphine, etc.)
- Inhalants
- Stimulants (cocaine, crystal meth, etc.)
- Cocaine (crack, rock, snow, blow)
- Methamphetamine (jib, crystal, speed)
- Club drugs (XTC, GHB, roofies)
- Ecstasy (E, X, love doves, adam)
- GHB (liquid E, easy lay, cherry meth)
- Rohypnol (roofies, date rape drug, forget me pill)
- Hallucinogens (LSD, mushrooms, mescaline, etc.)

- LSD (acid)
- Mushrooms (‘shrooms, cubes, psilocybin)
- Steroids

When was the last time you: (never, more than a year ago, in the past year, in the past month, in the past week)

1. Used caffeine
2. Used tobacco
3. Drank alcohol
4. Used over the counter drugs
5. Used prescription drugs
6. Used marijuana
7. Used other illicit drugs

*Exercise and diet*

Have you ever:

1. Exercised for more than 30 minutes
2. Exercised in a team sport or group activity
3. Exercised individually
4. Played organized sports
5. Been on a diet
6. Tried to lose or gain weight

*Specific Physical Exercise Checklist*

Check each of the following activities you have engaged for exercise in the past twelve months

Individual

- Cycling (road, mountain, BMX)
- Walking
- Running/Track
- Swimming
- Hiking
- Skateboarding
- Weight lifting
- Exercise classes
- Exercise machines
- Skiing/Boarding
- Water Skiing/Wake boarding
- Other (specify)

Team sports/ activities

- Basketball
- Football
- Soccer
- Racket sports
- Hockey
- Dancing
- Volleyball
- Baseball
- Other (specify)

*Experienced or perpetrated violence*

Have you ever:

1. Experienced any form of violence
2. Witnessed any form of violence
3. You threatened to harm someone?
4. You physically harmed someone?
5. You spread a rumour about someone that wasn't true?
6. You excluded someone?
7. Someone threatened to harm you?
8. You were verbally bullied?
9. You were physically harmed?
10. A rumour was spread about you that wasn't true?

*Entertainment and Socializing*

Have you ever:

1. Attended a party in a house or apartment
2. Attended a party outside
3. Attended church
4. Engaged in church activities
5. Participated in an organized group or club
6. Used a social networking site (ex., Facebook, Myspace, Nexopia etc.)
7. Chatted on an instant messenger (ex., MSN, Yahoo Chat)
8. Sent text messages
9. Watched a movie
10. Listened to music

11. Went to a concert or play

12. Visited a museum or art gallery

*Frequency of behaviours*

In the past two weeks, how many times did you drink:

- three drinks in one setting
- four or more drinks in one setting

How many days in the past 30 have you done the following and how much did you like this activity: (all participants)

- Talked on the phone
- Watched music videos
- Went to the mall
- Hung out with friends
- Listened to music
- Watched television
- Played video games
- Watched movies/DVD/videos
- Watched late night television
- Played sports
- Went to a sporting event
- Exercised for more than 20 minutes
- Did hobbies
- Played a musical instrument
- Did homework

- Went to a music or dance lesson
- Spent time with my family
- Went to a party
- Went to church
- Socialized with friends in a social setting (ex., a pub, restaurant, coffee shop etc.)?
- Go out to the movies?
- Chatted on an instant messenger (ex., MSN, Yahoo Chat)?
- Sent text messages?
- Played computer games?
- Played games on the internet?
- Talked on the phone with friends
- Watched music videos
- Spend time alone
- Hang out with friends
- Play an instrument
- Use the Internet
- Do hobbies (draw, crafts, etc.)
- Attended a party in a house or apartment
- Attended a party outside
- Engaged in church activities
- Participated in an organized group or club
- Used a social networking site (ex., Facebook, Myspace, Nexopia etc.)
- Gone to a concert or play

- Visited a museum or art gallery

*Quantity of behaviours*

Think of a typical day when you (insert option below). How many would you have per day?

- Had a standard drink of alcohol - (Standard drink defined as glass of wine, bottle or can of beer, a cooler, or 1 ½ ounces of liquor.)
- Smoked cigarettes
- Smoked marijuana

Think about what you have done in the past 30 days. In a typical week, how many hours do you do the following activities?

- Do homework
- Talk on the phone
- Watch music videos
- Spend time alone
- Listen to music
- Hang out with friends
- Play an instrument
- Watch TV
- Watch movies/DVD/videos
- Play video games
- Use the Internet
- Do hobbies (draw, crafts, etc.)
- Socialize with friends in a social setting
- Chat on an instant messenger (ex., MSN, Yahoo Chat)

- Watch TV
- Talk on the phone
- Send text messages
- Play computer or internet games
- Exercising

*Miscellaneous questions*

What motivates you to exercise? (check all that apply)

- Weight-loss
- Increase physical fitness
- Maintain physical fitness
- Medical concerns
- Aesthetics

What was your age the first time you: (contingent on positive response above)

- Drank alcohol
- Smoked marijuana
- Drank a caffeinated beverage
- Used tobacco



## Appendix E

## Substance use risk profile+ (SURPS+)

Participants rated their agreement on a 5-point likert scale (Strongly Agree, Agree, Undecided, Disagree, Strongly Disagree) on each of the following questions:

1. I am content.
2. I often don't think things through before I speak.
3. I would like to skydive.
4. I am happy.
5. I often involve myself in situations that I later regret being involved in.
6. I enjoy new and exciting experiences even if they are unconventional.
7. I have faith that my future holds great promise.
8. It's frightening to feel dizzy or faint.
9. I like doing things that frighten me a little.
10. It frightens me when I feel my heart beat change.
11. I usually act without stopping to think.
12. I would like to learn how to drive a motorcycle.
13. I feel proud of my accomplishments.
14. I get scared when I'm too nervous.
15. Generally, I am an impulsive person.
16. I am interested in experience for its own sake even if it is illegal.
17. I feel that I'm a failure.

18. I get scared when I experience unusual body sensations.
19. I would enjoy hiking long distances in wild and uninhabited territory.
20. I feel pleasant.
21. It scares me when I'm unable to focus on a task.
22. I feel I have to be manipulative to get what I want.
23. I am very enthusiastic about my future.
24. I feel that my family cares about me
25. I have seen a lot of violence in school
26. My family is affectionate
27. I feel I am treated well by the people in my neighbourhood
28. I spend a lot of time by myself
29. My family always looks after me
30. People older than me are mean to me
31. I have seen a lot of violence in my life
32. Fighting is a normal part of life
33. My family is always there for me
34. I have seen a lot of violence in my neighbourhood
35. I never go hungry

## Appendix F

CRAFFT (Knight, Sherritt, Harris, Gates, & Change, 2003)

Participants responded "Yes" or "No" to each of the following questions to indicate their risk drug and alcohol behaviours in the past 12 months.

1. Have you ever ridden in a car driven by someone who was using alcohol or drugs (including yourself)?
2. Do you ever use alcohol or drugs to relax, feel better about yourself or fit in?
3. Do you ever use alcohol or drugs while you are by yourself, alone?
4. Do your family or friends ever tell you that you should cut down on your drinking or drug use?
5. Do you ever forget things you did while using alcohol or drugs?
6. Have you ever gotten into trouble while you were using alcohol or drugs?

A score of two or more positive responses requires further screening for drug and alcohol problems.

## Appendix G

## Drug abuse screening test (Yudko, Lozhkina, &amp; Fouts, 2007)

The following questions concern information about possible involvement with drugs not including alcoholic beverages during the past 12 months. Participants read each statement and chose "Yes" or "No".

In the following statements "drug abuse" refers to:

- a. the use of prescribed or over-the-counter drugs in excess of the directions, and
- b. any nonmedical use of drugs.

The various classes of drugs may include cannabis (marijuana, hashish), solvents (e.g., paint thinner), tranquilizers (e.g., Valium), barbiturates, cocaine, stimulants (e.g., methamphetamine, speed), hallucinogens (e.g., LSD) or narcotics (e.g., heroin). Remember that the questions do not include alcoholic beverages.

Please answer every question. If you have difficulty with a statement, then choose the response that is mostly right.

1. Have you used drugs other than those required for medical reasons?
2. Do you abuse more than one drug at a time?
3. Are you unable to stop using drugs when you want to?
4. Have you ever had blackouts or flashbacks as a result of drug use?
5. Do you ever feel bad or guilty about your drug use?
6. Does your spouse (or parents) ever complain about your involvement with drugs?
7. Have you neglected your family because of your use of drugs?
8. Have you engaged in illegal activities in order to obtain drugs?

9. Have you ever experienced withdrawal symptoms (felt sick) when you stopped taking drugs?
10. Have you ever had medical problems as a result of your drug use (e.g., memory loss, hepatitis, convulsions, bleeding)?

Appendix H  
Demographics Questionnaire

Age: \_\_

Sex: Female or Male

Marital status: Single, Dating/courting, Engaged, Married

Year in College/University Program: 1, 2, 3, 4, 5, Graduate Student

Religion: Buddhist, Catholic, Christian, Christian Orthodox, Hindu, Jewish, Muslim, Protestant,  
Sikh, Other religion, None

Appendix I  
Consent Form

You are requested to participate in a study that looks at the relationship between different past experiences and where people's eyes move when looking at various pictures. Kim McCrea, an undergraduate student at the University of British Columbia Okanagan, is conducting this study to successfully complete an honours thesis in psychology. The supervising professor is Dr. Marvin Krank.

The purpose of this study is to expand current knowledge on the relationship between individuals past experiences with numerous activities such as exercise, social activities, drugs, alcohol, recreation, and art history. The goals of this study are to contribute to perspectives regarding these concepts developed in past research and provide areas for further research.

If you choose to participate, you will answer a number of questions from different instruments, taking approximately 50 minutes to 1 hour to complete. Some questions ask personal information about your drug and alcohol experiences. Pictures considered sensitive in nature will also be shown. Viewing these is the only perceived risk associated with this study. All responses will be completely anonymous and confidential. Your identity will in no way be associated with your responses.

Your participation in this study is completely voluntary, and there will be no penalty to you if you decline participation. Also, if you feel uncomfortable, please do not participate. Further, if at any point you feel uncomfortable completing the survey, you may stop without penalty. However, once the study has been submitted, you will be unable to withdraw your responses.

Should any further questions regarding this research project arise, please feel free to contact the supervising professor Dr. Marvin Krank at [marvin.krank@ubc.ca](mailto:marvin.krank@ubc.ca). Should any questions regarding the conduct of this study arise, please feel free to call the University of British Columbia Research Ethics Board at 604.827.5112



## Appendix J

## Debriefing form

Thank you for participating in this study. Your participation is greatly appreciated. You will now be credited 1 SONA credit. Remember to assign this credit to one of your eligible courses. The purpose of this study is to compare many different experiences individuals have had and how they look at pictures differently. Due to the possibility of influencing other participants' responses to this study, we ask that you do not discuss the tasks or purpose of this study with others.

Should you feel that you need to deal with any feelings or thoughts as a result of completing this study, please contact any of the resources listed on the resources form. Should any further questions regarding this research project arise, please feel free to contact the supervising professor Dr. Marvin Krank at [marvin.krank@ubc.ca](mailto:marvin.krank@ubc.ca). Should any questions regarding the conduct of this study arise, please feel free to call the University of British Columbia Research Ethics Board at 604.827.5112. We hope that you enjoyed this experience and choose to participate in research studies again.

**Resource List**

**This is a list of local resources you can access:**

**Help and information lines.** These are available 24 hours a day and are confidential.

|  |                     |
|--|---------------------|
| <b>Crisis Line</b>                         | <b>234.234.5678</b> |
| Alcohol and drug information and referrals | 1.800. 234.5678     |
| Health Information                         | 1.800. 234.5678     |

**Some places in town you can go to or phone are:**

|                    |                 |
|--------------------|-----------------|
| Friendship Society | 1.800. 234.5678 |
|--------------------|-----------------|

110 Friendship St.

Mental Health Services

1.800.234.5678

110 Health St.

***Healthcare and counselling services***

Campus Health and Wellness

234.234.5678

Community Resources

234.234.5678

110 Resources St.

Public Health Nursing

234.234.5678

110 Health St.