Affective Processing in Acute Alcohol Intoxication

by

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Abstract

Maladaptive decision-making that typifies drug addiction could reflect alterations in cognitive and emotional processing when these individuals are faced with choices. Even if this is true, it is not clear whether these deficits are a cause or a consequence of chronic drug use. The following experiments were designed to determine the effect of acute alcohol intoxication on affective processing in healthy individuals, as measured through a variety of behaviours. In the first experiment, acute alcohol intoxication did not impair performance on a task that recruits the orbitofrontal cortex, a key area for decision-making. In the second experiment examining preference formation, there was a clear dissociation between alcohol’s effect on implicit and explicit memory: acute intoxication impaired explicit memory, while leaving implicit learning intact. In a subsequent experiment, both alcohol and placebo groups showed altered physiological and subjective responses to a psychosocial stressor. Although acute alcohol intoxication did not affect risk-taking, an individual variable (tension-reactivity) moderated performance on this laboratory task. This experiment also revealed a relationship between stress-reactivity and subsequent risk-taking, one explanation being that high levels of cortisol increased individual sensitivity to task outcomes. Finally, an analysis of the accumulated information on drinking rates, impulsivity, and drug use suggests that female drinking rates may be approaching the levels reported by males. There were also significant differences in sensitivity to alcohol’s effects when participants were intoxicated in the lab. Heavy drinkers showed a greater sensitivity to the pleasurable effects of alcohol despite feeling less intoxicated and desiring more alcohol than other individuals. These combined effects could put heavy drinkers at greater risk for alcohol-
related problems. Taken as a whole, these studies suggest that individual factors play a stronger role in moderating affective processing than do the direct pharmacological effects of alcohol.
Statement of Originality

The conceptualization, the design, the data collection, the statistical analyses as well as the writing of the manuscripts were primarily carried out by the author. Cella Olmstead assisted in the conceptualization of the experiments and the writing of all manuscripts. Tara MacDonald and Ingrid Johnsrude contributed to the writing of the first and second published manuscripts, respectively. Katherine Wynne-Edwards assisted in the experimental design and the writing of the third manuscript. I hereby certify that all of the work described within this thesis is the original work of the author. Any published (or unpublished) ideas and/or techniques from the work of others are fully acknowledged in accordance with the standard referencing practices.

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February 2008
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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AA</td>
<td>Alpha-amylase</td>
</tr>
<tr>
<td>ANOVA</td>
<td>Analysis of Variance</td>
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<tr>
<td>BAL</td>
<td>Blood Alcohol Level</td>
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<tr>
<td>CEOA</td>
<td>Comprehensive Effects of Alcohol Questionnaire</td>
</tr>
<tr>
<td>CPP</td>
<td>Conditioned Pattern Preference</td>
</tr>
<tr>
<td>Df</td>
<td>Degrees of freedom</td>
</tr>
<tr>
<td>DEQ</td>
<td>Drug Effects Questionnaire</td>
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<tr>
<td>DSM-IV</td>
<td>Diagnostic and Statistical Manual IV</td>
</tr>
<tr>
<td>DUQ</td>
<td>Drug Use Questionnaire</td>
</tr>
<tr>
<td>FH-</td>
<td>Negative family history of addiction</td>
</tr>
<tr>
<td>FH+</td>
<td>Positive family history of addiction</td>
</tr>
<tr>
<td>HPA</td>
<td>Hypothalamic Pituitary Adrenal</td>
</tr>
<tr>
<td>IGT</td>
<td>Iowa Gambling Task</td>
</tr>
<tr>
<td>IQR</td>
<td>Interquartile range</td>
</tr>
<tr>
<td>KUSTA</td>
<td>Kurz-Skala Stimmung/Aktivierung</td>
</tr>
<tr>
<td>M</td>
<td>Mean</td>
</tr>
<tr>
<td>NT</td>
<td>Newman Perseveration Task</td>
</tr>
<tr>
<td>OFC</td>
<td>Orbitofrontal cortex</td>
</tr>
<tr>
<td>PDH</td>
<td>Personal Drinking Habits</td>
</tr>
<tr>
<td>POMS</td>
<td>Profile of Mood States</td>
</tr>
<tr>
<td>SAM</td>
<td>Sympathetic Adrenal Medulla</td>
</tr>
<tr>
<td>SD</td>
<td>Standard deviation</td>
</tr>
<tr>
<td>SE</td>
<td>Standard error</td>
</tr>
<tr>
<td>SEM</td>
<td>Standard error of the mean</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Package for the Social Sciences</td>
</tr>
<tr>
<td>TSST</td>
<td>Trier Social Stress Test</td>
</tr>
<tr>
<td>VMF</td>
<td>Ventromedial Prefrontal Cortex</td>
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Chapter 1: General Introduction

Some drink to make them wide awake, And some to make them sleep:
Some drink because they merry are, And some drink because they weep.
Some drink because they’re very hot, And some because they’re cold;
Some drink to cheer them when they’re young, And some because they’re old.
Some drink to give them appetite, And some to aid digestion;
Some, for the doctor says it’s right, And some without question.
Some drink when they a bargain make, And some because of loss;
Some drink when they their pleasure take, And some when they are cross.
Some drink for the sake of company, While some drink on the sly;
And many drink but never think About the reason why.

- J Milton Smith, *Nuts to Crack for Moderate Drinkers*, 1890

Behavioural responses to alcohol vary considerably among individuals. Because of this, research is now shifting from a focus on pharmacological mechanisms of alcohol to cognitive and motivational effects that may explain differential responses to the drug. More specifically, many researchers are now examining the cognitive factors moderating the effects of alcohol as a means to reconcile contradictory findings in the literature. This investigation integrates different lines of research ranging from neural systems to cognitive mechanisms to emotional processing. The work ultimately has implications for the understanding and treatment of many mental illnesses including substance abuse.

One of the key components of both cognitive and emotional processing is decision-making. Decision-making is the ability of humans and animals to choose between several competing options. Each of these options is associated with potential
rewards or costs that must be evaluated quickly, based on their relative value. The decision-making process is dynamic and flexible as it integrates information regarding different potential consequences, thereby forming the foundation for the voluntary control of behaviour. Examples of decision-making include choices such as buying a specific product, deciding to have surgery, or settling on a candidate to vote for in an election. These examples highlight the fact that decision-making is abstract (the process is not visible), and lies somewhere between reason and emotion; it can be deliberate (e.g. “This candidate’s platform has a stronger emphasis on social issues”) or reflexive (e.g. “He just seems like a nice guy”). It is clearly affected by motivational processes (e.g. buying too much food when grocery shopping hungry) as well as cognitive ones (“The operation will be painful, but afterwards I’ll be able to walk properly”).

Adaptive decision-making usually reflects the tendency to think about the consequences of a planned act prior to engaging in the act (Bechara, Noel & Crone, 2006). The option associated with the greatest reward or the smallest loss is usually the one chosen. Nonetheless, the options generated, and the relative reward signals associated with each of these alternatives, are determined subjectively. The cognitive processes underlying decision-making are most apparent when they are maladaptive. For example, in an addicted state, individuals repeatedly choose the short-term high of a drug over rewards associated with long term abstinence (health, family, career, etc). The diagnostic criteria for Substance Dependence, as defined by the Diagnostic and Statistical Manual for Mental Disorders (DSM-IV), includes a decline or termination of social, occupational or recreational activities as well as continued drug use despite recurrent physical or psychological problems due to the substance use (American Psychological Association,
1994). These markers of dysfunction are important to note because the actions of addicts are not reflexive or robotic; they are voluntary. Obtaining money for drugs, buying the drug, finding a place to shoot up etc. all require a great deal of time, organization, deliberation as well as cognitive flexibility (American Psychological Association, 1994; Hyman, 2007).

Chronic abuse of addictive drugs results in brain and behavioural changes that subsequently alter responses to rewards and cues that predict them. Drug addicts show a heightened response to rewards (Bechara & Damasio, 2002; Rogers, Owen, Middleton, Williams, Pickard, Sahakian & Robbins, 1999) suggesting an increased incentive value of the reward. Indeed, drug addicts consistently perform poorly on decision-making tasks by choosing greater immediate gains and ignoring future consequences (Rogers, Everitt, Baldacchino, Blackshaw, Swainson, Wynne, Baker, Hunter, Carthy, Booker, London, Deakin, Sahakian, & Robbins, 1999; Grant, Contoreggi & London, 2000; Bechara & Damasio, 2002). This inability to forfeit immediate for delayed rewards is characteristic of an altered motivational system. Although many addicts express a sincere desire to stop using drugs, they nonetheless continue to forsake their family, friends, career and health for the short-lived high of a drug. The desire of an addict to stop abusing drugs and their inability to resist intense drug cravings emphasizes a rift between rational cognitive and motivational processes that influence a person’s decision to continue abusing drugs. Indeed, the motivation for immediate drug use often becomes so strong that addicts will abandon all other aspects of their lives to engage in drug use. The intense cravings experienced by addicts support the idea of ‘incentive salience’ (Robinson & Berridge, 1993, 2003), whereby salient features related to drug use hijack attentional processes of
the individual. Automatically and involuntarily, any salient cues for drug use elicit ‘wanting’ of the drug and may influence behaviour without conscious awareness of the individual. This phenomenon is not unique to addiction: phobic individuals show an attentional bias for stimuli related to their phobic target (e.g. spiders), and individuals with eating disorders focus more on food-related words and pictures (Martin & Jones, 1995; Stormark & Torkildsen, 2004). Thus, both appetitive and aversive stimuli produce emotional changes that prioritize stimuli during information processing, leading to altered cognitive patterns. These attentional biases are most likely involved in the development and maintenance of the disorder, whereby the body gives emphasis to emotional disturbances (either pleasant or aversive) and increases the saliency of related stimuli (Williams, Mathews & MacLeod, 1996).

**The role of the OFC in decision-making**

One brain area gaining increasing attention for its role in decision-making is the orbitofrontal cortex (OFC). The OFC, positioned on the ventral and medial surfaces of the frontal lobe, extends from the frontal pole, through part of Brodman’s area 11, area 13 and 14 medially, area 12 laterally and area 47 posteriorly (Ongur & Price, 2000). There is some evidence for a functionally distinct subregion on the innermost OFC (Ongur & Price, 2000), although the delineation and function of this ventromedial area is still debatable. The OFC has a large number of intrinsic connections, as well as extensive reciprocal connections with the amygdala and the ventromedial striatum, including the nucleus accumbens (Ongur & Price, 2000). The extensive connections from the OFC to the hypothalamus are indicative of the former’s influential role in homeostatic control (Ongur & Price, 2000).
In novel or uncertain situations, the OFC plays an important role in rapid stimulus-reinforcement learning and in monitoring any changes in reward contingencies (Elliott, Dolan & Frith, 2000; Rolls, 2004). Planning and guessing tasks, in which feedback over trials is necessary for learning, activate the OFC with a greater neural response associated with increasing options (Elliott et al., 2000). This area, therefore, is important for the acquisition of stimulus-reinforcement contingencies (especially in unpredictable situations) and for holding this information ‘on-line’ in working memory (Elliott et al., 2000). Single-electrode recording in the OFC of macaques confirms that these cells respond to the motivational value of a reinforcer, rather than the physical properties of the stimulus (Tremblay & Schultz, 1999). With respect to motivated behaviours, such as eating, the effective processing of motivational cues would promote the recognition of palatable foods, as well as eating of a specific food until satiation before moving on to another food. This adaptive behavior promotes nutritional variety and helps to maintain healthy individuals (Kringelbach & Rolls, 2004). An intriguing neuroimaging study demonstrated this process with diminishing OFC activity in participants as they ate chocolate to satiety (Small, Zatorre, Dagher, Evans, Jones-Gotman, 2001).

A further understanding of OFC function is gained by examining deficits following OFC damage. OFC lesions do not affect the normal acquisition of a conditioned response in rats, although lesioned animals do not show a change in responding upon devaluation of the reinforcer (Gallagher, McMahan & Schoenbaum, 1999). This suggests that the OFC plays a crucial role in associative learning by providing motivational guidance through a comparison between the expected and actual outcome (Gallagher et al., 1999). Similarly, humans with lesions to the OFC demonstrate
defective social and emotional behaviours, with difficulties in adapting to any changes in reinforcement contingencies (Damasio, 1994). The ambiguous and changing conditions presented in social situations account for the inappropriate behaviour of these patients. As well, excessive deliberation times for simple decisions demonstrate that these individuals are incapable of selecting a specific option. The striking personality change seen with OFC damage has been described as ‘acquired sociopathy’, where individuals show social inappropriateness, irresponsibility and lack of affect (Damasio, 1994). A remarkable feature of these individuals is their ability to verbally express the correct answer, while remaining incapable of producing the right response (Damasio, 1994).

Given the role of the OFC in motivational learning and decision making, it is not surprising that drug addicts exhibit OFC dysfunction. These include structural changes through grey matter loss and persistent functional changes in OFC activity (Franklin, Acton, Maldjian, Gray, Croft, Dackis, O’Brien & Childress, 2002; Bolla, Eldreth, London, Kiehl, Mouratidis, Contoreggi, Matochik, Kurian, Cadet, Kimes, Funderburk & Ernst, 2003; Ersche, Fletcher, Roiser, Fryer, London, Robbins & Sahakian, 2006). Behavioural tasks requiring decision-making and that recruit the OFC also reveal impaired performance in drug addicts (Bechara & Damasio, 2002; Bechara, Dolan & Hindes, 2002; Bolla et al., 2002; Rogers et al., 1999. Volkow and colleagues (2000) have suggested that repeated over stimulation of the OFC and its associated network, through chronic drug use, results in neural changes that maintain the addiction cycle. These neural alterations produce changes in conscious processes, experienced as craving, as well as in unconscious processes, such as conditioned expectation or impulsivity, that keep a person attuned to drug reward and drug-related cues (Volkow & Fowler, 2000). During initial
withdrawal, chronic drug abusers show hyperactivity of the OFC that is proportional to the intensity of their cravings, while during protracted withdrawal, the OFC is hypofunctional (Volkow & Fowler, 2000). These findings are consistent with the idea that OFC dysfunction is related to compulsive drug-taking behaviours, rather than the pleasure-producing properties of the drugs. More importantly, OFC dysfunction may explain why, after years of abstinence, people often relapse (Volkow & Fowler, 2000).

**The Somatic-Marker Hypothesis**

One of the first attempts to build a comprehensive theory of OFC functioning was the Somatic Marker Hypothesis (Damasio, 1994). This theory described patients with OFC damage who demonstrated intact learning, memory and intellect yet were socially inappropriate and exhibited deficits in emotional processing. Based on this evidence, Bechara and colleagues (2000) emphasized that emotions play a critical role in decision-making by biasing the reasoning process. Because the OFC has extensive and reciprocal connections with both the hypothalamus and brainstem, it may function as the connection between factual knowledge and a bio-regulatory state (Ongur & Price, 2000; Bechara et al., 2000). In this way, the OFC connects previously experienced emotions with predicted future outcomes, thereby marking a decision as favourable or unfavourable. These markers enhance attention and working memory to specific choices and act as efficient shortcuts in guiding adaptive behaviour. The covert influence of these somatic markers is a simple heuristic so that the decision-making process can occur easily and efficiently; rather than considering all of the options, the body simply marks the most useful or realistic ones and rapidly rejects those that are not endorsed. This theory accounts for why OFC patients fail to learn from their mistakes in everyday life, and also explains
why these individuals often show excessive deliberation times when pondering choices. The absence of somatic markers can result in ‘interoceptive agnosia’, when an individual is unable to judge their own reaction and is therefore incapable of making an adaptive choice. Neuroimaging supports the role of the OFC in mediating interoceptive awareness; activity in this area is related to tonic skin conductance levels, a measure of sympathetic activity when individuals perform biofeedback arousal or relaxation tasks (Nagai, Critchley, Featherstone, Trimble & Dolan, 2004).

Patients with OFC damage do not typically show impairment on traditional neuropsychological tests, so Damasio and colleagues developed the Iowa Gambling Task (IGT) which effectively highlights the decision-making deficits evidenced in this population. On this task, individuals must choose between ‘disadvantageous’ decks of cards that produce high rewards with higher penalties, and ‘advantageous’ decks with low rewards but lower penalties. Healthy individuals begin by playing from the high-paying disadvantageous decks but, following large penalties on these decks, quickly switch to the safer advantageous decks. Interestingly, individuals begin switching to advantageous decks, prior to any conscious knowledge of the correct strategy – an example of nondeclarative, or implicit learning (Bechara et al., 1997). Emotional arousal, measured through skin conductance response (SCR), increases in healthy individuals prior to making a risky choice from one of the disadvantageous decks. Patients with OFC damage do not produce anticipatory increases in SCR prior to risky choices from the disadvantageous decks; these individuals continue to play from the disadvantageous decks, eventually losing all of their money (Bechara et al., 1997). Remarkably, these individuals can verbally describe the damaging reward schedule of the risky decks, yet
are unable to adapt their playing strategy away from these decks. This dissociation between knowledge and behaviour highlights how conceptual understanding of the task does not guarantee advantageous decision-making.

In addition to OFC patients, drug addicts consistently exhibit performance deficits in the IGT (Mazas, Finn & Steinmetz, 2000; Petry, Bickel & Arnett, 1998; Bechara, Dolan, Denburg, Hindes, Anderson & Nathan, 2001; Bechara & Damasio, 2002; Bechara, Dolan & Hindes, 2002; Bolla et al., 2003). Not all substance-dependent individuals are impaired, but a subset of these consistently choose disadvantageously and also fail to generate an anticipatory SCR response prior to their risky choices (Bechara & Damasio, 2002). Even substance-dependent individuals who perform normally on the task show abnormally large SCR responses following reward, suggesting that these individuals may be hypersensitive to reward (Bechara, Dolan & Hindes, 2002). Neuroimaging studies confirm greater OFC activation is associated with advantageous performance on the IGT, whereas prior drug use is negatively correlated with activity in this area (Bolla et al., 2003).

Although the Somatic Marker Hypothesis provides an interesting functional account of OFC involvement in decision-making, this theory is not without critics. Some have described the theory as a revamping of the James-Lange Theory of Emotion using a glorified reversal-learning task (Rolls, 1996). Bechara and colleagues refute this claim by pointing out that many individuals with OFC damage still perform well on the Wisconsin Card Sorting Task, a commonly used neuropsychological test of set-shifting (Bechara et al., 2005). Perhaps the strongest criticism of the Somatic Marker Hypothesis is that it is
unparsimonious and difficult to falsify through its use of complicated representation of somatic states (Krawczyk, 2002).

Despite these criticisms, the IGT is currently one of the most utilized neurocognitive tasks, administered to a variety of populations including individuals with schizophrenia, bulimia nervosa and Parkinson’s disease (Shurman, Horan & Nuechterlein, 2005; Boeka & Lokken, 2006; Pagonabarraga, Garcia-Sanchez, Llebaria, Pascual-Sedano, Gironell & Kulisevsky, 2007). Bechara and colleagues (1997) emphasize that, the IGT has an advantage over many other decision-making tasks in that it provides a measure of nondeclarative or implicit memory. That is, healthy individuals begin to choose advantageously prior to conscious knowledge about the task.

**Implicit cognition**

Because implicit emotional processes have such a strong influence on decision making, explicit questioning of attitudes and motivations has proven inadequate in clarifying the cognitive mechanisms of addiction. Thus, a growing number of addiction researchers are employing tests of implicit cognition. These measures are used to assess, indirectly, an attitude or cognition that may be unavailable to the conscious awareness of an individual (De Houwer, 2006). Tests of implicit cognition, therefore, can be used to examine unconscious or automatically activated processes that influence thought, action and feeling. Because these are unavailable to introspection, they are not affected by self-justification (Wiers & Stacy, 2006).

Alcohol intoxication increases the reliance on implicit or automatic processes, rather than explicit processes, such as working memory, which are generally impaired in an intoxicated state (Lister, Gorenstein, Risher-Flowers, Weingartner & Eckardt, 1991;
Tiffany & Conklin, 2000). Rational control over drug intake, therefore, may be impaired through alcohol’s impeding effect on controlled processes (Vogel-Sprott, Easdon, Fillmore, Finn & Justus, 2001). This suggests that intoxication, through effects on associative memory processes, biases an individual to respond automatically rather than deliberately accessing alternative strategies (Stacy, 1997). In support of this idea, changes in cognitive processes produced by drug use increase reliance on implicit processes as well as the likelihood for further drug abuse (Fillmore & Vogel-Sprott, 2006). Indeed, even after controlling for gender, ethnicity and socio-economic status, implicit cognitions remain one of the strongest predictors of prospective drug use (Stacy, Ames, Sussman & Dent, 1996).

In general, research examining the effects of acute alcohol intoxication report that explicit cognitions, such as working memory, are impaired, whereas implicit processes remain unaffected (Lister et al., 1991; Kirchner & Sayette, 2003). Some studies, however, show facilitative effects of intoxication on memory when emotional, rather than neutral, cues are used. For example, alcohol produces a retrograde facilitation of memory for emotional images, but an anterograde impairment for both emotional and neutral images (Knowles and Duka, 2004). These findings suggest a limitation of processing capabilities at the encoding stage of memory and may partially explain why serial drinkers fail to learn from their maladaptive behaviour despite the negative consequences of their actions (Knowles & Duka, 2004). Similarly, using an implicit learning procedure, Bruce & Pihl (1997) found that healthy individuals showed an enhanced delayed recall for emotional verbal memories acquired prior to alcohol ingestion. Alcohol can also alter learning processes in healthy individuals when information is acquired in an intoxicated, rather
than a sober, state. Moderate doses of alcohol reduce negative, but not positive, priming (i.e. exposure to a prime slows the subsequent reaction time) on a Stroop colour-naming task (Fillmore, Dixon and Schweizer 2000). This finding suggests that intoxicated individuals have problems with selective inhibition, in that alcohol prevented the inhibitory process that normally causes a delay in subsequent responding. Interestingly, this attenuation of the negative priming response occurred at a moderate dose of alcohol, whereas a higher dose of alcohol (0.75g/kg) abolished the negative priming response. The eradication of negative priming at higher doses may reflect, once again, alcohol’s disruption of processing at the encoding stage of memory.

Although there is often an assumption that specific tasks measure implicit cognition while others measure explicit cognition, automatic and non-automatic processes most likely lie on a continuum with both simultaneously influencing task performance. Most studies of implicit cognition use tests such as priming and word-stem completion tasks, which may be contaminated by explicit processes (Kirchner & Sayette, 2003). For example, the use of alcohol-related words in the Stroop task to test interference effects of alcohol-related stimuli may present a confound in which previously presented words explicitly prime participants on a task which is meant to examine implicit memory (e.g. Kramer & Goldman, 2003). Furthermore, the use of predominantly lexical and semantic tasks may not be ecologically valid in reflecting natural associative learning in the environment.

Another criticism of studies examining the acute effects of alcohol on implicit learning is methodological: the alcohol administration procedure has participants consuming very large quantities of alcohol in very short periods of time (e.g., 5 minutes),
so as to test participants on the ascending limb of the blood alcohol curve. This procedure, however, does not realistically reflect common drinking practices in which alcohol is usually consumed over several hours. Furthermore, by using very specific memory tests in which encoding and retrieval are separated, the tests do not reflect the learning process as a whole, which often occurs within one drinking session (Soederlund, Parker, Schwartz & Tulving, 2005). Moreover, many of these experimental tasks lack incentives, in that they require participants to learn neutral, semantic information, whereas associative learning in the environment most likely involves cues that are not linguistic.

**The Stress Response in Assessing Affective Processes**

In the past two decades, research has begun to highlight how motivational processes may be reflected through stress responses. Stress can be defined as any “bodily or mental tension resulting from factors that tend to alter an existent equilibrium” (Merriam-Webster, 1993). During stress, a force is placed on the system that constitutes a homeostatic disruption and the body must produce a stress response in which it provides a compensatory reaction to the challenge (Lovallo, 2005). The hypothalamic pituitary adrenal (HPA) axis plays an important role in regulating these physiological adaptations in response to stress. Very rapidly, this system reacts to any change in either internal or external environments through a cascade of neurochemical changes including the release of the hormone cortisol (see Kirschbaum & Hellhammer, 1994 for a review). Stress can be generated internally or externally but both ultimately use the same physiological system to respond to this disruption. The threat value of internal stressors is created through the *evaluation* of the stressor, rather than the stressor itself (Lovallo, 2005). In
this case, cortisol receptors in the limbic system and prefrontal cortex exert a top-down influence in mediating stress reactivity. Cortisol measures, therefore, can function as an indirect assessment of affective processes in these brain areas (Lovallo, 2006). For this reason, HPA functioning is being used increasingly in addiction research to gauge disruptions of brain motivational systems in healthy and pathological populations (Lovallo, 2006).

This work has revealed that alcoholic and polysubstance-abusing men display an attenuated cortisol response to a psychosocial stressor (Lovallo, Dickensheets, Myers, Thomas & Nixon, 2000). Notably, these individuals did not differ in diurnal cortisol regulation, supporting the idea that the hyporesponsiveness of the HPA axis results from altered activity in higher cortical structures (Lovallo et al., 2000). Blunted cortisol responses have also been observed in individuals with a family history of alcoholism, polysubstance-abusers without comorbid psychiatric illnesses, as well as in heavy social drinkers (Sorocco, Lovallo, Vincent & Collins, 2006; Zimmermann, Spring, Kunz-Ebrecht, Uhr, Wittchen & Holsboer, 2004; Contoreggi, Herning, Na, Gold, Chrousos, Negro, Better & Cadet, 2003; King, Munisamy, de Wit & Lin, 2006). Acute alcohol intoxication increases cortisol secretion (Mendelson, Ogata & Mello, 1971), suggesting that low reactivity of the HPA axis may act as a biomarker for abuse potential (King et al., 2006). The attenuation of the stress response has implications for the hypothesized motivational balance between reward and punishment; in that low cortisol levels are related to disadvantageous decision-making (van Honk, Schutter, Hermans & Putman, 2003).

**Proposed Series of Experiments**
The proposed series of experiments set out to determine the effect of acute alcohol intoxication on affective processing in healthy individuals as measured through a variety of behaviours. The first experiment was a continuation of my Master’s work, examining intoxicated decision-making using the IGT, and includes family history and recreational drug use measures. The second experiment looked at preference formation in intoxicated individuals as they performed an implicit learning task. The third experiment sought to examine psychological controls and HPA axis reactivity associated with risk-taking following psychosocial stress. Finally, the accumulated information on age, drinking rates, impulsivity, and family history was combined from across all of the studies to gain an accurate representation of current drinking habits in a Canadian undergraduate population.
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Chapter 2:

Instructional Cues Modify Performance on the Iowa Gambling Task

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Abstract

The current study investigated whether acute alcohol intoxication produces impaired decision-making on tasks assessing ventromedial prefrontal cortex (VMF) functioning and impulsive responding. Participants completed the Iowa Gambling Task (IGT), a decision-making test targeting the VMF, and the Newman Perseveration Task (NT), a measure of impulsivity. Personality measures of impulsivity were assessed using the Barratt Impulsiveness Scale (BIS). To encourage natural responding on the impulsivity tasks, participants were falsely informed that the study was examining the effects of alcohol on memory retention. Thus, the impulsivity tasks were presented as ‘distractor’ tasks. Advantageous performance on the IGT was related to specific instructional cues as well as to knowledge about the experimental purpose. Performance of intoxicated and sober participants did not differ. A subsequent study in which the true purpose of the experiment was revealed confirmed that alcohol does not affect IGT performance. Most importantly, the instruction-sensitivity of the IGT emphasizes the importance of salient cues for decision-making.

Keywords: decision-making, ventromedial prefrontal cortex, alcohol, impulsivity, personality, reward
2.0 Introduction

Impulsivity and decision-making have gained attention in recent years as key components underlying many disorders including Substance-Related Disorders, Attention-Deficit and Disruptive Behavior Disorders, Psychopathy, Eating Disorders, as well as certain Personality Disorders (Bulik, Sullivan, Carter & Joyce, 1997; Lilenfeld, et al., 1997; Mitchell, Colledge, Leonard & Blair, 2002; Petry, Bickel & Arnett, 1998; Lynskey & Hall, 2001). These disorders are characterized by poor decision-making, in which immediate gratification is chosen at the expense of long-term goals. Healthy individuals, under the influence of alcohol, frequently make impulsive choices that disregard future consequences and often engage in socially inappropriate behaviour. Ethanol administration in the laboratory, however, does not always produce impulsive behaviour in humans (Richards, Zhang, Mitchell & de Wit, 1999; Ortner, MacDonald & Olmstead, 2003). Although some studies have shown that intoxicated individuals gamble longer and place higher wagers (Kyngdon & Dickerson, 1999), others have found individuals behave less impulsively when intoxicated (Ortner et al., 2003), while still others find that betting is related to personality measures of sensation seeking rather than alcohol consumption (Breslin, Sobell, Cappell, Vakili & Poulos, 1999). A key assumption underlying research in this area is that willingness to gamble is increased consistently by alcohol across all individuals (Breslin et al., 1999), a misconception that may explain the mixed findings.

Although studies of signal detection with intoxicated individuals (Dougherty et al., 1999; Dougherty, Marsh, Moeller, Chokshi, & Rosen, 2000; Mulvihill, Skilling, & Vogel-Sprott, 1997) do show more consistent results, a major drawback of both signal
detection and hypothetical choice tasks is that they cannot adequately assess impulsiveness and decision-making. Motivational factors may vary dramatically between tasks and attempts to eliminate these (see Mulvihill et al., 1997), disregard this key component of impulsive behaviour. Furthermore, the face validity of many tests is very high. For example, asking a participant whether they would prefer $1 now or $10 next week clearly expresses the purpose of the experiment; an individual can quite easily guess at what the ‘right’, or rational, response should be. Tests using hypothetical choices do not necessarily capture real-life decision-making and participants, even when intoxicated, are still conscious of the fact that they are being tested and may respond with deliberate rationality. Moreover, this line of questioning assumes a conscious type of reasoning, whereby the participant can clearly and explicitly weigh the pros and cons and arrive at a logical and reasonable answer. Although these tests may measure the most efficient reasoning strategy, it is not necessarily the one used in decision-making. In everyday life, when problems requiring a choice arise, they are usually poorly defined, with multiple possibilities and unpredictable outcomes.

Decision-making in everyday life is often reactive and unreflective, thereby preventing the use of conscious reasoning. Newman and colleagues (1987) developed a card game that tests impulsive responding by incorporating unpredictable rewards, punishments, response adaptation and learning from aversive events (Patterson & Newman, 1993). The card game measures perseverative responding (the tendency to continue a dominant response, despite changes in reward contingency or punishment) and individuals must learn to inhibit responding as reinforcement contingencies change and punishment becomes more likely (Newman, Patterson & Kosson, 1987). Impulsive
behaviour, in this view, is a by-product of the unreflecting disinhibition process (Patterson & Newman, 1993). Psychopaths, given monetary rewards on the NT, show significantly higher rates of perseverative behaviour; they continue to play cards, even in the face of increased punishment, and lose their money (Newman et al., 1987). Nonalcoholic men with a multigenerational familial history of alcoholism also show impaired responding on this task, playing until they lose most of their money (Giancola, Peterson & Pihl, 1993).

In contrast to the disinhibition processes measured in the NT, the IGT is a simulated gambling test that contra poses immediate reward against future punishment and mimics real life decision-making (Bechara, Damasio, Damasio & Anderson, 1994; Damasio, 1994). Decision-making is an evaluative process in which outcomes and strategies may vary, whereas impulsivity presents only one correct solution and no dilemma (Bechara, 2003). The IGT was originally developed to test decision-making in individuals with damage to the ventromedial prefrontal cortex (VMF), who show defective social cognition with abnormalities in emotional processing (Damasio, 1994; Bechara, Damasio & Damasio, 2000; Bechara, Tranel & Damasio, 2000). On the task, individuals have the choice between card decks yielding high monetary rewards but higher losses (therefore ‘disadvantageous’ decks) or decks with low rewards but lower penalties (thus, ultimately ‘advantageous’ decks) (Bechara et al., 1994). Although each card deck is associated with a specific schedule of win-lose ratios, an exact calculation of deck payoffs is not possible, therefore players are faced with a conflict between playing from decks of risky high rewards or from those with lesser punishment. Patients with VMF damage consistently play from the disadvantageous decks, eventually losing all of
their money (Damasio, 1994; Bechara et al., 1994; Bechara, Damasio, Tranel, & Damasio, 1997). Healthy individuals quickly learn to play from the advantageous decks, whereas VMF patients, even over time, do not change their playing strategy (Bechara et al., 2000). Recent studies examining other psychiatric populations with impulsive features have shown that psychopaths and substance abusers show impaired performance on the IGT as well (Bechara et al., 2001; Bechara & Damasio, 2002; Grant, Contoreggi, & London, 2000; Mitchell et al., 2002).

The current study used lifelike gambling tasks, the NT and the IGT, to investigate whether acute alcohol intoxication produces decision-making deficits akin to those observed in individuals with VMF dysfunction. The use of healthy individuals allowed for the study of impulsiveness and the characterization of responding prior to any pathology. Participants completed the Barratt Impulsiveness Scale as a measure of trait impulsivity. To decrease face validity and encourage natural responding, participants did not know the real purpose of the study. Instead, they were informed that the experiment was examining the effects of acute alcohol intoxication on memory. Participants were informed that between memory tests, they would complete distractor tasks, to prevent rehearsal of memorized words. These distractor tasks were, in fact, the measures of impulsivity and decision-making. Our hypothesis was that intoxicated individuals would show greater impulsivity on the NT, by playing more cards. On the IGT we hypothesized that intoxicated participants would demonstrate decision-making deficits through increased playing from disadvantageous decks A & B.

To avoid drawing too much attention to the ‘distractor’ tasks, simplified instructions were initially presented for the gambling tasks. Unexpectedly, however,
performance of control participants did not reach the level generally reported for the IGT. For this reason, after 40 participants completed the study, the instructions for this task were changed so that they were identical to those used by Bechara and colleagues. Finally, to assess performance with full knowledge of the experimental purpose, another 50 participants were randomly assigned to alcohol, placebo or sober conditions. These participants were all informed that the experiment was examining the effect of alcohol on decision-making.

2.1 Methods

2.1.1 Participants

Participants were 127 male undergraduate students ranging in age from 19 to 25 at Queen’s University. All participants received $10 monetary compensation for their participation in the study or course credit. Each participant completed the Barratt Impulsiveness Scale, the Memory Test, the IGT and the NT.

2.1.2 Measures

2.1.2.1 The Barratt Impulsiveness Scale.

The Barratt Impulsiveness Scale (BIS), version 11, is a 30 item self-report questionnaire examining impulsive traits (Patton, Stanford & Barratt, 1995). The participant rates the statements on a 4-point scale: rarely/never, occasionally, often, or almost always. All the items on the scale are intercorrelated from .15 to .42. The BIS also contains 3 subscales: Nonplanning, Motor and Cognitive Impulsiveness. Items within the Nonplanning and the Motor Impulsiveness subscales correlate between .46 and .53 with one another, while those on the Cognitive Impulsiveness subscale load on all of the factors (Patton et al., 1995). The BIS has been translated into different languages and its
test-retest reliability ranges from .71 to .89 (Someya, Sakado, Seki, Kojima, Reist, Tang, & Takahashi 2001; Fossati, Di Ceglie, Acquarini, & Barratt, 2001).

2.1.2.2 Memory Test.

The Memory Test is a computerized task in which 20 words are flashed on the screen one at a time for 5 s. Participants are told that after completing a distractor task, they will be shown a series of words and asked whether they recognize each from the initial list. The Memory Test is used to hide the true purpose of the experiment and thereby promote natural responding.

2.1.2.3 The Iowa Gambling Task.

The IGT is a computerized version of Bechara and Damasio’s gambling task (Bechara et al., 1997) which consists of 4 decks of cards labeled A to D, with each card representing either a win or loss of money. Initially, the instructions were simplified to maintain the blind of the study’s purpose:

_In this card game there are four decks of cards. You can draw cards from any of the decks. Every time you click on card, you will win some play-money. With some card draws you will lose money as well. The object of the game is to win as much play-money as possible, or avoid losing as little of the money as possible. You will begin the game with $2000._

A message appears on the screen after each card-turn indicating the amount of money that has been won or lost. The total amount of points is displayed at the top of the screen. Decks A and B produce large rewards (usually over $100), however, the penalties are higher, making these decks disadvantageous. Conversely, decks C and D contain smaller rewards (usually $50), but the overall penalties are far less, thereby ultimately
producing the greatest amount of money. Participants are asked to maximize their winnings, but are not told that their playing is limited to 100 card-turns. Typically, control participants begin by selecting cards from the disadvantageous decks, but over trials quickly learn to play from the advantageous decks which produce lower penalties (Bechara & Damasio, 2002). With the former instructions, participants (N = 40) did not demonstrate this pattern and performed at a level far below that reported by others (Bechara et al, 1997; Damasio, 1994). Therefore, after failing to reach standard performance on the task, instructions were changed for the subsequent 87 participants to be identical to those used by Bechara and colleagues:

1. In front of you on the screen, there are 4 decks of cards: A, B, C, and D.
2. When we begin the game, I want you to select one card at a time by clicking on a card from any deck you choose.
3. Each time you select a card, the computer will tell you that you won some money. I don’t know how much money you will win. You will find out as we go along. Every time you win, the green bar gets bigger.
4. Every so often, when you click on a card, the computer will tell you that you won some money as usual, but then it will say that you lost some money as well. I don’t know when you will lose or how much. You will find out as we go along. Every time you lose, the green bar gets smaller.
5. You are absolutely free to switch from one deck to the other at any time, and as often as you wish.
6. The goal of the game is to win as much money as possible and avoid losing as much money as possible.
7. You won’t know when the game will end. Simply keep on playing until the computer stops.
8. I am going to give you $2000 of credit, the green bar, to start the game. The red bar is a reminder of how much money you borrowed to play the game and how much money you have to pay back before we see whether you won or lost.
9. The only hint I can give you, and the most important thing to note is this: Out of these four decks of cards, there are some that are worse than others, and to win you should try to stay away from bad decks. No matter how much you find yourself losing, you can still win the game if you avoid the worst decks.
10. Also note that the computer does not change the order of the cards once the game begins. It does not make you lose at random, or make you lose money based on the last card you picked.
2.1.2.4 The Newman Perseveration Task

The NT is a computerized version of the Newman, Patterson and Kosson (1987) card-playing task in which subjects were told to maximize their winnings by turning over face cards, but were penalized when they turned over other, non-face cards. The deck consisted of 100 cards and subjects were told to quit when they thought they had won the maximum amount. The card deck, however, consisted of 10 subdecks of cards where the first subdeck contained 9 winning cards (i.e. face cards) and 1 losing card, the next subdeck consisted of 8 winning cards and 2 losing cards, and so on, with losses surpassing winnings after the 5th subdeck.

2.1.2.5 Manipulation Check.

Upon completion of the computerized tasks, participants were asked to fill out a final questionnaire as a manipulation check for their perceived level of intoxication and mood. This questionnaire was modified from a self-report Drug Effects Questionnaire (DEQ) by Ortner, et al., (2003). Questions included a participant’s estimation of the amount of alcohol consumed, their level of intoxication and whether they would like more alcohol. Also, participants were asked to rate their performance on the memory test and the distractor tasks. A question on the participant’s understanding of the experiment’s purpose assessed the extent to which they were aware of the hypotheses.

2.1.3 Procedure

This study was approved by the General Research Ethics Board at Queen’s University.

Participants were randomly assigned to either an intoxicated (BAL>.08%, n = 45), placebo (n = 41), or control (n = 41) group. All participants were (falsely) informed
that the study was examining the effects of alcohol on memory retention over time. After giving consent, all participants filled out the BIS.

Participants were weighed at the beginning of the session. The intoxicated group received 3 alcoholic drinks consisting of a 2:1 ratio of Fresca soda to Alcool (40% alcohol), so as to raise their blood-alcohol level (BAL) to the legal limit in Ontario (.08%). Participants in the placebo group were told that they were receiving alcohol, although their drinks consisted of Fresca soda mixed with Tonic water. The glasses were rimmed with alcohol, so as to convincingly smell of alcohol, without affecting the BAL of the participants. The control group was informed that they were not receiving any alcohol. Participants viewed two episodes of ‘The Simpsons’ (totaling ~55 minutes) while consuming the drinks. The appropriate alcohol mixture was divided into 3 glasses, each consumed at 20-min intervals. Prior to beginning the computerized tasks, as well as just after completion, individuals in the intoxicated groups had their BAL measured using the Intoxilyzer breathalyzer test.

Participants completed the tasks in the following order: first the initial Memory Words, followed (randomly) by either the IGT or the Response Perseveration Test. A test of the Memory Words followed, and the series finished with either the IGT or the Response Perseveration Test. Upon completion of the computerized tasks, participants filled out the DEQ. Lastly, a feedback sheet was provided to all participants in which they were fully debriefed on the real purpose of the study.

Following the finding that task instructions and knowledge of experimental purpose was related to performance (i.e., those that suspected the ‘distractor’ tasks were the real experimental purpose performed significantly better), a new group of
undergraduates was recruited and tested using the protocols described above. These 50 participants (19 females, 31 males) were correctly informed that the study was examining the effect of alcohol on decision-making. They were then assigned to either alcohol, placebo, or control conditions and completed only the IGT using the full instructions.

2.2 Results

2.2.1 Manipulation Check

2.2.1.1 Estimated level of intoxication

The placebo manipulation was examined through self-report measures of intoxication on the DEQ. Five one-way ANOVAs revealed that the experimental groups differed in their perceived level of intoxication \( (F(2, 124) = 173.11, p < .01) \), in their estimates of bottles of beer consumed \( (F(2, 124) = 221.37, p < .01) \), in their ratings of alcohol in the mixed drinks \( (F(2, 124) = 64.77, p < .01) \), in their estimated BALs \( (F(2, 124) = 8.74, p < .01) \) and on feeling sober or drunk \( (F(2, 103) = 218.12, p < .01) \). Bonferroni posthoc comparisons showed that the groups differed in a stepwise fashion: participants in the alcohol group rated themselves as significantly more intoxicated than participants in the placebo group \( (p < .01) \), who in turn rated themselves more intoxicated than the control group \( (p < .01) \). The alcohol group also scored themselves higher than the placebo group on estimates of number of bottles of beer consumed \( (p < .01) \), percentage of alcohol in the mixed drinks \( (p < .01) \), and feeling sober/drunk \( (p < .01) \). The placebo group, relative to the control group, rated themselves as having consumed more bottles of beer \( (p < .01) \), and feeling more intoxicated \( (p < .01) \). The estimated BAL of the intoxicated group \( (M = 0.21) \) was rated significantly greater than the control group \( (p < .01) \), and the placebo group \( (p < .01) \). The actual mean BAL for the intoxicated
group, as measured by the Breathalyser, was 0.093 (SD = 0.04), therefore the experimental manipulation to raise the participants’ BAL to 0.08 was effective. For further analyses, the placebo and control group were collapsed into one ‘sober’ group, as no other differences existed for these groups.

2.2.2 Iowa Gambling Task

One participant admitted to prior experience with the IGT, therefore this individual’s data were excluded from the analyses.

2.2.2.1 Instructional differences

The performance of participants receiving different instructions on the IGT is shown in Figure 1. The first 40 participants in the study received a simplified version of the instructions, whereas the subsequent 86 participants received the full instructions. A 2 (instructions) by 5 (trials) repeated measures ANOVA revealed a significant main effect of instructions ($F(1, 124) = 9.56, p < .01$), trials ($F(3.32, 411.97) = 3.93, p < .01$), as well as an interaction between instructions and trials ($F(3.32, 411.97) = 5.34, p < .01$). The total mean score for the group receiving simple instructions was -2.42 (SE = 1.07) and that for the full instruction group 1.56 (SE = 0.72). A Bonferroni- adjusted multiple comparison test revealed, that scores of the full instruction group increased over trials, such that all mean trial block scores for this group were significantly higher than the first 20 trials ($p < .01$) and were significantly greater than the scores for the simple instruction group after 20 trials ($p < .05$).

2.2.2.2 Alcohol intoxication

Behavioural performance on the IGT for the 86 participants receiving full instructions is shown in Figure 2. A 2 (group) by 5 (trials) repeated measures ANOVA
Figure 1. The effect of instructional cues on Iowa Gambling Task performance. Points represent the mean score for each block of 20 trials collapsed across treatment groups. Net score was calculated by subtracting disadvantageous card deck draws (decks A and B) from advantageous card deck draws (decks C and D). Negative scores represent predominant playing from disadvantageous decks.
Figure 2. The effect of treatment on Iowa Gambling Task performance. All participants received full instructions. Each point represents the mean score for 20 trials.
showed no main effect of experimental group ($F(1, 84) = 1.17, p = .28$). Although the mean score for the intoxicated group was lower than the sober group on all blocks of trials, this difference did not reach statistical significance due to the large variability of scores within groups (intoxicated $M = 0.48, SE = 1.27$; sober $M = 2.20, SE = 0.97$).

A main effect of trial showed that scores increased across trials ($F(3.33, 279.70) = 10.94, p < .01$). The mean score for the first block of trials was significantly lower than for the four following blocks of trials ($p < .01$), however the last four blocks did not differ from one another. There was no interaction between experimental group and trials.

2.2.2.3 Apprehension of experimental purpose

Participants were initially misinformed that the purpose of the experiment was to examine the effects of alcohol on memory. To test whether the blind was successful, the last question on the DEQ asked participants to explain their understanding of the purpose of the experiment. Answers were coded into 3 groups according to their proposed explanation: the ‘No Knowledge’ group ($n = 51$) reported the purpose as “to test the effects of alcohol on memory”; the ‘Suspicion’ group ($n = 17$) mentioned that the experiment might have had another purpose and wondered whether the ‘distractor’ tasks were important; while the ‘Knowledge’ group ($n = 19$) clearly stated that the real purpose of the experiment was to test the effects of alcohol on gambling behaviour and decision-making. Figure 3 displays the performance of these 3 groups over 5 blocks of trials. A 3 (group) by 5 (trial) repeated measures ANOVA revealed a marginally significant between-subjects effect ($F(2, 83) = 2.97, p = .06$), such that no knowledge of the true purpose of the experiment was associated with lower scores than those who
Figure 3. The effect of apprehension of experimental purpose on the Iowa Gambling Task performance. The ‘No knowledge’ \((n = 50)\) group believed the experiment was testing the effects of alcohol on memory. The ‘Suspicion’ group \((n = 17)\) suspected that the distractor tasks were also important. The ‘Knowledge’ group \((n = 19)\) guessed the correct purpose of the experiment.
guessed the real purpose on the IGT \( (p = .06) \). A Bonferroni-adjusted multiple comparison revealed significantly greater means for the ‘Suspicion’ and the ‘Knowledge’ groups than the ‘No Knowledge’ group only on the fourth block of trials (61-80), although these first two groups did not differ from one another.

### 2.2.2.4 Alcohol intoxication with knowledge of the experimental purpose

Behavioural performance on the IGT with full knowledge of the experimental purpose \((n = 50)\) is shown in Fig. 4. A 2 (group) by 5 (trials) repeated measures ANOVA showed no main effect of intoxication \((F(4, 188) = 22, p > .01)\). There was no interaction between experimental groups and trials.

The overall mean for females \((M = 3.84)\) was slightly lower than that of male participants \((M = 6.21)\), however this difference was not statistically significant \((F(1, 48) = 1.80, p = .19)\).

### 2.2.3 Newman Perseveration Task Performance

Group means on the different behavioural measures of the NT are displayed in Table 1. Three one-way ANOVAs yielded no significant differences between experimental groups on the number of card selections \((F(2, 124) = 0.24, p > .05)\), total time spent on the task \((F(2, 124) = 1.47, p > .05)\), or on the total winnings for the task \((F(2, 124) = 0.13, p > .05)\).

### 2.2.4 Barratt Impulsiveness Scale

The grand mean on the BIS was 63.94 \((SE = 0.76)\) and there was no difference between experimental group means on the total BIS score \((F(2, 124) = 0.23, p > .05)\), the Nonplanning subscale \((F(2, 124) = 0.03, p > .05)\), the Motor subscale \((F(2, 124) = 1.45, p > .05)\) or the Cognitive subscale \((F(2, 124) = 0.28, p > .05)\).
Figure 4. The effect of treatment on Iowa Gambling Task performance with knowledge of experimental purpose. Participants completed only the Iowa Gambling Task with full instructions. Each point represents the mean score for 20 trials.
Table 1

Newman Perseveration Task performance.

<table>
<thead>
<tr>
<th></th>
<th>Alcohol</th>
<th>Placebo</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$n = 45$</td>
<td>$n = 41$</td>
<td>$n = 41$</td>
</tr>
<tr>
<td>Cards selected (/100)</td>
<td>51.27 (4.95)</td>
<td>52.07 (5.18)</td>
<td>55.98 (5.18)</td>
</tr>
<tr>
<td>Time spent on the task (s)</td>
<td>59.81 (5.15)</td>
<td>70.20 (5.40)</td>
<td>71.30 (5.40)</td>
</tr>
<tr>
<td>Amount of money won ($)</td>
<td>18.71 (1.49)</td>
<td>19.75 (1.56)</td>
<td>18.98 (1.56)</td>
</tr>
</tbody>
</table>

All values are means (SEM).
2.2.4.1 Newman Perseveration Task correlations

There were no correlations between BIS scores and total cash won or the total number of cards played on the NT. A Pearson correlation coefficient of -0.218 ($p < .01$) between the nonplanning subscale of the BIS and the total time to complete the task, revealed that participants with higher nonplanning impulsivity quit playing earlier than those with lower scores.

2.3. Discussion

The large difference in performance between groups receiving simplified versus full instructions on the IGT demonstrates that salient instructional cues are necessary for optimal performance on this task. Presentation of simplified instructions (i.e., gain as much money and lose as little money as possible) produced sub-standard performance, akin to VMF patients, such that participants played predominantly from the disadvantageous decks, losing all their money, with no improvement over the 100 trials. Participants who received the full, detailed instructions rapidly improved their performance, selecting predominantly from the advantageous decks after only 20 trials. The difference in performance between these two groups can be explained by the fact that the full instructions provide many more clues for advantageous performance. In the full instructions, emphasis is placed on the fact that the experimenter does not manipulate the decks according to the participant’s card selections. The full instructions also draw attention to cues for performance monitoring, such as the green bar that increases with money gains and the red bar that increases with losses. Notably, the full instructions clearly state that there are ‘good’ and ‘bad’ decks, and successful performance depends on avoidance of the bad decks. The instruction-sensitivity of the IGT reinforces the
importance of cue salience in successful decision-making. To date, no study has examined the effects of instructions on the IGT and most studies using this task, or variations of it, rarely report the instructions received by the participants (e.g., Grant et al., 2000; North & O’Carroll, 2001). The present findings suggest that this is a critical variable that should be controlled for, otherwise the results of the study will be uninterpretable (e.g., Schmitt, Brinkley & Newman, 1999). Other important factors that may influence performance include visual cues (the happy and sad faces that pop up with wins and losses), as well as the auditory slot-machine noises that accompany each card selection.

Another significant finding of this study is that knowledge of the experimental purpose may play a role in advantageous performance on the IGT. Participants who guessed the real purpose of the experiment performed significantly better in contrast to those who believed the card games were ‘distractor’ tasks (Fig. 3). It should be noted, however, that regardless of knowledge level, scores increased across all groups. Although knowledge of the experimental purpose was a naturally occurring variable (and therefore may be influenced by a third variable), these results are nonetheless consistent with the idea that a greater understanding of the task is related to advantageous performance. In contrast, these findings differ from those of Evans, Kemish and Turnbull (2004), who reported that tertiary-educated participants scored significantly lower on the IGT than those who were school-educated until the age of 16. Participants in both studies were matched in age and education; the discrepancy, therefore, may reflect a gender difference. The Evans et al. study consisted of only female participants, whereas the current study consisted of both males and females performing the IGT with full
knowledge of the experimental purpose. Although not statistically significant, there
was a trend for females to score lower than males in our study. These results are
consistent with the findings of Bolla, Eldreth, Matychik, and Cadet (2004), who reported
gender differences in IGT performance, that correlated with brain activity while
completing the task.

Contrary to the original hypothesis, alcohol intoxication did not produce
disadvantageous performance on the IGT. It is possible, however, that the lack of
knowledge about the experimental purpose masked group differences. When the effects
of apprehension of experimental purpose are controlled for, the net score for the control
and intoxicated group reach the average score attained by normal control subjects in other
studies using this task (Figure 4; Bechara et al., 2000; Bechara et al., 2001; Bechara and
Damasio, 2002). The similarity between undergraduate (i.e. 19-25 year olds) and older
adult scores supports the idea of functional maturation of the VMPFC during this time
period, as 14-17 year-olds do not yet perform at this level (Hooper, Luciana, Conklin, &
Yarger, 2004). Examination of the BAL curves of the intoxicated group showed that
almost all participants were tested on the descending limb of the blood alcohol
concentration curve, the limb that has been associated with impaired performance on tests
of executive cognitive functioning (Pihl, Paylan, Gentes-Hawn & Hoaken, 2003). The
large variability in task performance within the alcohol group, however, suggests that
individual differences in response to alcohol, rather than the biphasic effect of this drug,
may better account for the behavioural effects of alcohol.

Alcohol also did not promote disinhibited behaviour on the NT; the intoxicated
group discontinued playing shortly following the 5th subdeck, thereby maximizing their
winnings. The participants’ performance in the current study indicated that they were motivated; all groups continued playing until penalties began to outnumber rewards and their response patterns did not differ from that of participants in other studies (Patterson & Newman, 1993). The lack of correlations between the BIS and the NT may indicate that this task does not tap into the features measured by the BIS.

2.3.1. Conclusions

The unimpaired performance of the intoxicated group on the IGT suggests that individual characteristics, rather than the direct action of ethanol, may play a more important role in decision-making. The finding that instructions significantly modify performance, although unexpected, is of extreme importance, given the widespread use of this task. Future studies using the IGT should be very careful to provide participants with full instructions as well as disclosure of experimental purpose so as to control for these potential confounds.
Foreword to Chapter 3

Chapter 3 consists of a manuscript published in November 2007 in *Alcoholism: Clinical and Experimental Research* 31, 1-11. The author’s supervisor, M.C. Olmstead, and committee member, Ingrid Johnsru, are co-authors on this paper.
Chapter 3:

Intact Preference Conditioning in Acute Intoxication

Despite Deficient Declarative Knowledge and Working Memory

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Abstract

The impact of alcohol on implicit, emotional learning is not well understood, partly because family history, drug use and task demands influence these processes. The Conditioned Pattern Preference (CPP) task provides a more ecologically valid means to investigate implicit cognition in the lab because it has low demand awareness and relies on learning to associate nonverbal cues with reward. This study examined the effects of acute alcohol intoxication on implicit learning using the CPP task in 83 intoxicated and 69 sober young adults. Information on individual drug use, family history, impulsivity and alcohol expectancies was also collected. Alcohol intoxication affected explicit, but not implicit, learning on the CPP task. In addition, participants who reported a positive family history of addiction (FH+) or individual recreational drug use did not exhibit a preference for cues previously paired with reward. Preference formation on the CPP task recruits motivational neurocircuitry, an effect that is unaltered by alcohol. Group differences in implicit emotional learning on this task may represent neurocognitive differences in individuals at risk for addiction.

Key Words: Implicit Learning, Alcohol, Family History, Addiction, Orbitofrontal Cortex.
3.0 Introduction

There is a general perception that acute alcohol intoxication disrupts learning and memory in healthy individuals. It is to the frustration of many researchers, therefore, that alcohol often shows equivocal effects in the laboratory, possibly because its effects depend on so many different factors (Balodis, MacDonald & Olmstead, 2006; Bruce, Shestowsky, Mayerovitch & Pihl, 1999; Fillmore, Dixon & Schweizer, 2000). For example, the effect of alcohol on learning depends on whether participants are tested on the ascending or descending limb of the blood alcohol concentration curve, the specific behavioural task, and whether alcohol is administered during learning acquisition or prior to retrieval (Pihl, Paylan, Gentes-Hawn & Hoaken, 2003; Soederlund, Parker, Schwartz & Tulving, 2005). The variability in alcohol’s effects on learning and memory may also be explained by cognitive factors that differentially moderate the effects of alcohol (Sayette, 1999).

Another factor that may affect the influence of alcohol on learning and memory is the face validity of the task. If the demand awareness for the task is very high, intoxicated individuals may respond according to task demands, rather than reacting as they would in non-laboratory settings. Individuals may also be influenced by their own expectations of the effects that alcohol may have and behave accordingly (Finnigan, Hammersley & Millar, 1995). Both of these confounds can be reduced by using an implicit learning paradigm. Implicit cognition refers to automatic or effortless influences on thought, action and feeling, which mostly operate without conscious awareness of the individual (Fillmore & Vogel-Sprott, 2006). Conversely, explicit or non-automatic cognition denotes slower, deliberate thought processes, such as attention, that are subject to limited-
capacity processing (Sayette, 1999). Because implicit cognition is unavailable to introspection, it is less likely to be influenced by social desirability. Studies of implicit cognition are used increasingly in addiction research because they provide a means to examine the motivation and emotional processes underlying drug abuse (Wiers & Stacy, 2006).

In general, research investigating the effects of alcohol on implicit cognition suggests that alcohol leaves automatic processes unaffected, while disrupting explicit learning. For example, in healthy volunteers, alcohol reduces the number of words remembered on a free-recall test (explicit memory), whereas implicit measures such as word-completion, semantic priming, or simply the judgment of frequency estimation of word presentation are unaffected (Kirchner & Sayette, 2003; Lister, Gorenstein, Risher-Flowers, Weingartner & Eckardt, 1991; Ray & Bates, 2006; Tracy & Bates, 1999). Alcohol, therefore, may disrupt memory at the encoding stage by limiting processing capabilities of the intoxicated individual. It may restrict attention and conscious awareness, which is required for explicit learning. Some studies have shown facilitative effects of alcohol for emotional memories using incidental-learning paradigms (Bruce & Pihl, 1997; Knowles & Duka, 2004), possibly due to the arousing properties of emotional stimuli. One could argue that these findings are consistent with the ‘Alcohol Myopia’ theory, whereby restricted attention in intoxicated individuals results in an enhanced focus on the most salient information (Steele & Josephs, 1990). If true, the effect of alcohol on learning is still difficult to interpret due to differences in drug administration and testing procedures across studies. Effects vary depending on whether alcohol is taken before or after encoding and retrieval stages. In addition, tasks frequently involve verbal
or linguistic cues that are neutral (and therefore may not be very interesting to intoxicated individuals). Natural associative learning in the environment most likely involves cues that are nonverbal. We tried to model this in the lab using a paradigm that uses novel, abstract visual cues to examine implicit, emotional learning in intoxicated individuals.

Previous studies using this task have shown that affective properties associated with a conditioned stimulus need not be explicit, or conscious, in order to elicit conditioning (Johnsrude, Owen, Zhao & White, 1999). Our study examined how the intrinsic emotional significance of stimuli affects conditioning and judgments in healthy intoxicated individuals. Specifically, we were interested in testing whether intoxicated individuals condition differently to environmental stimuli associated with reward.

Individuals completed a challenging cognitive task with very low demand awareness. Participants are instructed to find a red ball hidden behind 1 of 3 black boxes on a computer screen. Simultaneously they are told to count how many black, or incorrect, balls they find behind each of the boxes. When participants click on a box, it ‘opens up’ to reveal either a red or black ball superimposed on an abstract pattern. If the ball was red, participants heard a pleasant melodic flourish and received a food reward. If the ball was black they heard an unpleasant buzzer sound and did not receive a food reward. Unbeknownst to the participant, their experience on a given trial depended only on the trial number, and not on the box they picked; the participant would get a particular outcome together with a particular abstract pattern. The “look for red balls” task was really just a cover for a conditioning procedure in which participants become conditioned to stimuli (3 different abstract patterns) associated with reward at different contingencies.
Following training on the task, participants were asked to make preference judgments on the 3 conditioned patterns as well as 3 novel patterns. Previous studies have shown that individuals prefer the pattern that is associated most frequently with reward, without any awareness of the conditioning procedure (Johnsrude et al., 1999). This computerized task recruits the brain regions involved in preference learning, including the amygdala, striatum and the OFC (Johnsrude, Owen, White, Zhao, & Bohbot, 2000; Cox, Andrade & Johnsrude, 2005). We hypothesized that, based on the saliency of rewarding stimuli, intoxicated individuals would show an increased preference for patterns associated with reward as well as a decreased preference for patterns associated with non-reward. We also hypothesized that even with this increased preference, intoxicated individuals would not be aware of the conditioning procedure.

3.1 Methods

3.1.1 Participants

Participants were 152 healthy undergraduate students (85 males and 67 females) from Queen’s University recruited through classes and a student volunteer subject pool. Eligibility criteria for the study included that the participant 1) reported no allergic reactions to alcohol; 2) had no medical conditions that contraindicated alcohol; and 3) reported consuming alcohol at least once per month. Participants were between the ages of 19 and 31. To ensure minimal risk of pregnancy, females were tested only during the luteal phase of their menstrual cycle or if they had not had sexual intercourse since their last menstrual cycle. All participants were asked not to eat for 3 hours prior to the experiment. An honorarium of 10 Canadian dollars was awarded to all participants upon
completion of the experiment. The experimental protocol was approved by the General Research Ethics Board of Queen’s University.

3.1.2 Measures

The Barratt Impulsiveness Scale

The Barratt Impulsiveness Scale (BIS), version 11, was used as a self-report measure of individual impulsive traits. The BIS is a 30-item questionnaire with Nonplanning, Motor and Cognitive Impulsiveness subscales. Participants rate themselves on statements using a 4-point scale: rarely/never, occasionally, often or almost always. All the items on the BIS are moderately correlated with each other and the scale shows a high test-retest reliability (Fossati, Di Ceglie, Acquarini & Barratt, 2001; Patton, Stanford & Barratt, 1995). This questionnaire was completed by 66 participants.

Drug Use Questionnaire

This self-report questionnaire contains questions regarding an individual’s drug use history and that of their family. The questionnaire also collects information regarding the type of drug and frequency of drug use. The last 5 questions are adapted from the South Oaks Gambling Questionnaire (Lesieur & Blume, 1987) examining the type and frequency of gambling behaviour. This questionnaire was completed by 66 participants.

Comprehensive Effects of Alcohol Questionnaire

The Comprehensive Effects of Alcohol Questionnaire (CEOA) is a comprehensive measure of discrete alcohol expectancies, including both positive and negative factors (Fromme, Stroot & Kaplan, 1993). The self-report questionnaire consists of 38 statements, first examining an individual’s expectation as to whether they are under the influence of alcohol using a 4-point Likert scale. These same 38 statements are then
subjectively evaluated on a 5-point Likert scale, in which the individual rates the particular effect as good, bad or neutral. These statements have been categorized into domains of Sociability, Tension Reduction, Liquid Courage, Sexuality, Cognitive and Behavioural Impairments, Risk and Aggression and Self-Perception. The CEOA demonstrates good test-retest reliability as well as construct and criterion validity (Fromme et al., 1993). This questionnaire was completed by 66 participants.

The Conditioned Pattern Preference Task

The CPP is a computerized implicit learning task developed by Johnsrude and colleagues (Johnsrude et al., 1999). Participants chose a food reward (either M&Ms or Cheerios Snack Mix) before beginning the task that they were allowed to eat following each correct trial on the CPP.

The CPP consists of 3 different phases that were presented in a fixed order: Formation, Judgment and Questions. The 3 experimental conditions are depicted in Figure 5. During the Formation phase, the individual reads the following instructions:

“You will see 3 boxes on the screen. At any time, one of the boxes is hiding a red ball, and the other two are hiding black balls. What you have to do is guess where the red ball is. I would like you to find as many red balls as you can.

You can choose a box by clicking on it with the mouse. Once you have selected a box, it will open up and show you which ball was hidden underneath. Every so often,
Figure 5. The 3 stages of the Conditioned Pattern Preference Task. In the *Formation* stage (A), participants are instructed to find the red ball behind 1 of the black boxes. When participants find a red ball, they hear a melodic flourish and are allowed 1 food reward. After a certain number of trials, participants are asked “How many here?” asking a participant to report how many black balls they noticed at these locations. Therefore, participants must find the red ball, while simultaneously keeping track of how many black balls they have noticed. In the *Judgment* phase (B), participants are shown 2 patterns and are asked to pick the 1 that they prefer. In the final *Questions* phase (C), participants are presented with the total tally of their choices from the Judgment phase and are questioned why they preferred certain patterns over others.
you will be asked to identify how many black balls you saw behind each of the three boxes. Thus, while you are choosing boxes you have also to try and remember how many black balls you have seen. You need to find as many red balls as you can.” Participants were also informed that they could eat one food reward (i.e. M&M or Cheerio) every time they find a red ball.

The *Formation* phase consists of the conditioning procedure and lasts approximately 35 minutes. During this time, participants chose one of the black ‘boxes’ on the screen, which ‘opened up’ to reveal a stimulus pattern with either a red or black ball superimposed on it. If the participant uncovered the red ball, they heard a melodic flourish through headphones and were allowed one food reward. If a black ball was revealed behind the box, the participant heard a buzzer tone and was not allowed a food reward. Therefore, for each trial, participants received visual and auditory and feedback on the outcome of their choice as well as gustatory feedback on rewarded trials.

Participants completed a total of 180 trials over six blocks comprising of 20, 30, 40, 40, 30 and 20 trials. After each of these blocks of trials, the question “How many here?” appeared under each of the 3 boxes. Participants then entered how many black balls they remember seeing at these locations. This counting task provided a measure of working memory in the experimental groups.

Unbeknownst to the participants, the trial order (i.e., the presentation of red and black balls) was pseudorandom and fixed. The 3 abstract monochrome stimulus patterns viewed by participants were associated with a 90%, 50% and 10% reward contingency. Because the pattern association was not absolute, the experimental contingencies were not obvious to most participants (as we show in the Results and discuss later in the
Moreover, the instructions for the task make no mention of the abstract patterns; because the individual was engaged in finding the red balls and counting the black balls, their attention was not explicitly drawn to the pattern stimuli.

The conditioning procedure consisted of 180 trials, in which each stimulus pattern was presented 60 times, with red and black balls, depending on the reward contingency. The rarest ball-pattern combination was presented immediately preceding and following the most frequent ball-pattern combination. Identical pattern-reinforcement pairings did not occur more than twice in a row. In this way, the conditioning procedure remained well disguised.

During the Judgment phase of the task, participants were shown 6 patterns: 3 familiar patterns previously viewed in the Formation phase and 3 novel patterns. Participants were instructed: “You will see two patterns on the screen. I would like you to choose the one that you prefer by clicking on it. Don’t think too hard; just go with your first impression.” Each pattern was presented 10 times, counterbalanced on the left and right side of the screen, in combination with the other patterns, for a total of 30 trials. The purpose of the Judgment phase is to assess whether participants have developed a preference for the conditioned patterns from the Formation phase by tallying the number of times each of the patterns is chosen.

During the final Questions phase of the task, the participants were shown the 6 patterns from the Judgment phase with a number representing the number of times they selected each pattern. Participants were then asked: “You picked this pattern X times. Why did you prefer this pattern?” for their top 2 choices. They were also asked: “You only picked this pattern X times. Why didn’t you like this pattern?” for the two least-
chosen patterns. The purpose of the Questions phase was to assess the participant’s knowledge of the experimental manipulation. That is, it specially probes whether participants attributed their pattern preference to physical attributes of the pattern, or whether they overtly recognized the conditioning procedure from the Formation phase of the task. The Judgment phase therefore assesses whether conditioning to the patterns has occurred, while the Questions phase assesses whether any preferences demonstrated during the Judgment phase are implicit or explicit. Up to this point in the task, there has been no explicit mention of the relationship between the patterns and the red and black ball pairings from the Formation phase.

*Declarative Knowledge Questionnaire*

With the Questions phase screen still present on the computer, participants were explicitly questioned regarding their knowledge of the pattern contingencies using the Declarative Knowledge Questionnaire. Participants were asked whether they saw any of the patterns during the first phase of the task, and if so, which ones. Participants were also asked whether they noticed that any pattern was paired frequently with the red ball and to point out which one. They were also asked which pattern most appeared with the black ball. To test whether task stimuli were recognizable, participants were asked to guess which 3 patterns were familiar from the task. Answers to all of these questions were dichotomously scored as correct/incorrect. Finally, participants were questioned regarding the certainty of their pattern choices, these responses were scored in an ordinal fashion, with ‘1’ as certain and ‘5’ as just guessing.

*Drug Effects Questionnaire and Manipulation Check*
Following the computer task, participants completed the DEQ and Manipulation Check, a self-report measure previously used in our laboratory to examine perceived level of intoxication and mood (Ortner, MacDonald & Olmstead, 2003; Balodis et al., 2006). In order to further judge the effectiveness of the placebo manipulation, participants were asked to estimate the amount of alcohol that they had consumed, and whether they would like more alcohol.

### 3.1.3 Procedure

This study followed the alcohol administration procedure previously used in our laboratory to examine the effects of alcohol on impulsivity (Balodis et al., 2006). Participants were randomly assigned to 1 of 3 treatment groups: sober \( n = 43 \), placebo \( n = 26 \) or intoxicated \( n = 83 \) and were informed that the experiment was examining the effects of alcohol on learning and memory. Informed consent was obtained from the participants and they completed the BIS, DUQ and the CEOA.

Participants in the intoxicated condition were weighed and received 0.7g/kg of alcohol in 3 drinks consisting of a 2:1 ratio of Fresca soda to alcohol (40% vodka). Participants in the placebo group were also weighed and told that they were receiving alcohol, however their drinks consisted of a 2:1 ratio of Fresca soda and flattened tonic water. The glasses of the participants in the placebo group were rimmed with alcohol, so as to convincingly smell of alcohol, without affecting the BAL of participants. The control group were told that they were not receiving any alcohol.

Participants watched 2 episodes of the Simpsons (approx. 55 minutes), as they consumed the beverages. One beverage was consumed approximately every 20 minutes.
Prior to, as well as following the computerized tasks, participants in the alcohol group completed an Intoxilyzer breathalyzer test.

Participants then completed the CPP, followed by the Declarative Knowledge and the DEQ and Manipulation Check. Lastly, participants received a Feedback Sheet disclosing the full purpose of the study and the different conditions. Following the debriefing, participants in the sober and placebo group were free to leave; however, individuals in the intoxicated group remained until their BAL was 0.06%, as measured by the breathalyzer. Participants in the intoxicated group were then provided with a taxi home.

Criterion Measures and Data Analysis

Data were analysed using SPSS version 14.0 for Windows. The dependent measures were analysed as follows:

*The Barratt Impulsiveness Scale*

Participant’s ratings on the BIS were summed according to those methods recommended by Patton and colleagues (1995). This includes a total BIS score as well as scores for the motor, nonplanning and cognitive impulsivity subscales. These data were analysed in one-way ANOVAs with the BIS score as the dependent variable and either experimental group, drug use group, or family history as a fixed factor.

*Drug Use Questionnaire*

Answers from questions on the DUQ were dichotomously scored as yes/no for family history and recreational drug use and accordingly individuals were divided into positive or negative groups (i.e. positive/negative family history and recreational/no recreational drug use). These data were analysed in repeated-measures ANOVA for
judgment scores using group as a between-subjects factor and patterns as a within-subjects factor.

One sample chi-square tests were used to examine the relationship between family history and recreational drug use. Chi-square tests were also used to examine explicit memory effects on the CPP, both for recreational drug use as well as for family history.

To examine the relationship between personal drinking habits and subjective effects of intoxication, positive and negative groups were used as fixed factors in ANOVAs with the personal drinking history and intoxication ratings as dependent factors.

*Comprehensive Effects of Alcohol Questionnaire*

Scores from the CEOA were tallied and divided into the 7 different subscales previously described as well as the positive and negative expectations recommended by Fromme and colleagues (1993). Scores on the CEOA were used as dependent measures in one-way ANOVAs with family history and recreational drug use from the DUQ as fixed factors.

*The Conditioned Pattern Preference Task*

A repeated-measures ANOVA was used to examine group effects on the CPP. The 90% and 10% reward patterns were used as within-subjects factors to test for an overall conditioning effect. Experimental group, gender, family history and recreational drug use group were all alternatively used as the between-subjects factor to test for conditioning differences between the two patterns. Test version was also included in the
repeated-measures ANOVAs (explanation in section 3.2.) resulting in a 3(test version) X 2 (group) X 2 (pattern) analysis of variance.

Performance on the counting task was assessed using a 2 (group) X 6 (trial block) repeated-measures ANOVA with trial block as the within-subjects factor and experimental group as the between-subjects factor.

_Declarative Knowledge Questionnaire_

The DKQ was used to assess explicit memory. Answers to the DKQ questions were dichotomously scored as correct/incorrect and used in a two-way chi-squared test with either experimental group, family history, or recreational drug use group as the other categorical variable.

_Drug Effects Questionnaire and Manipulation Check_

Subjective ratings examining perceived intoxication effects were analysed with one-way ANOVAs with the subjective rating as the dependent factor and either experimental group, drug use group, or family history as a fixed factor.

### 3.2 Results

#### 3.2.1 Manipulation check

3.2.1.1 Estimated level of intoxication

The mean BAL for the intoxicated group was 0.085 (SD = .03), therefore the experimental manipulation to raise the participants BAL to 0.08 was successful. Four participants did not complete the DEQ so these data are absent from the analyses. Four separate one-way ANOVAs verified that the placebo manipulation was effective in that there were significant group differences on each measure of this scale these data are displayed in Figure 6. The sober, placebo and intoxicated groups differed in their
Figure 6. Estimated levels of intoxication from the sober, placebo, and intoxicated groups. Significant group differences on each measure of the Drug Effects Questionnaire showed that the sober, placebo, and intoxicated groups differed in their subjective feelings of intoxication.
subjective ratings of feeling sober or drunk \((F(2, 145) = 137.36, p < .01)\), in their estimates of bottles of beer consumed \((F(2, 145) = 298.33, p < .01)\), in their ratings of alcohol content in the mixed drinks \((F(2, 145) = 6492.57, p < .01)\), and in their perceived level of intoxication \((F(2, 145) = 151.74, p < .01)\). A Bonferroni post-hoc comparison showed that the placebo group estimated consuming significantly less alcohol than the intoxicated group, but significantly more than the sober group \((p < .01)\). Similarly they estimated the alcohol content in their beverages as less than the intoxicated condition, but more than the sober group, therefore the placebo manipulation had a significant effect on the perception of alcohol intoxication.

### 3.2.2 Intrinsic pattern preferences

A one-sample \(t\)-test examining mean preference scores for the 6 patterns (maximum value = 10) using a test value of 5 (the expected mean preference if participants are indifferent to a particular pattern) revealed that one of the patterns was selected significantly more frequently \((p < .01)\), while 2 others were selected significantly less frequently \((p < .01)\). The most preferred pattern and one of these less preferred patterns had been used in the conditioning task, while the other less preferred pattern was only viewed during the Judgment Phase.

The intrinsic pattern preference may explain the significant effect of test version \((F(2, 149) = 8.222, p < .01)\) that was revealed following a 3 (version) X 2 (90% pattern, 10% pattern) repeated-measures ANOVA. A pairwise comparison revealed that, for the 90% rewarded pattern, version A had a significantly higher mean preference score than both versions B and C \((p < .01)\), and that these latter versions did not differ from one another. For the 10% rewarded pattern, version B had a significantly higher mean
preference score than versions A and C ($p < .01$), while the two latter versions were not significantly different from each other. Given the intrinsic preference for certain patterns, test version was included as an independent variable for each of the subsequent multivariate ANOVAs in order to conservatively control for this effect.

### 3.2.3 Preference learning

The results are based on the performance of 152 participants. Of these, 27 individuals (17.8%) explicitly related their preferences on the Questions phase to the initial pairing of the pattern with the red or black ball during the Formation phase (e.g. When questioned why they liked/disliked a specific pattern: “The pattern was always behind the black ball.”). All other participants ($n = 125$) related their preferences to the physical characteristics of the pattern (e.g. “Looks like a sun”). There was no significant difference in pattern preference between those who explicitly related their preferences to the task and those who did not ($F(1, 146) = 0.02, p = .89$).

#### 3.2.3.1 Alcohol intoxication

A 3 (test version) X 3 (group) X 2 (pattern) repeated-measures ANOVA showed a main effect of pattern ($F(1, 143) = 5.01, p < .05$), where the 90% pattern had a higher mean judgment score ($M = 5.79, SE = 0.27$) than the 10% rewarded pattern ($M = 4.91, SE = 0.25$). There was no main effect of experimental group ($F(2, 143) = .68, p = .51$) and no pattern X group interaction ($F(2, 143) = 1.26, p = .29$). As there were no significant differences in performance between the sober and placebo groups, these 2 groups were collapsed into one ‘sober’ group for all subsequent analyses (N=69).

Figure 7 displays the mean judgment scores for the 83 intoxicated and the 69 sober participants for the positively (90% rewarded) and negatively (10% rewarded)
Figure 7. The effect of treatment on the Conditioned Pattern Preference Task. Bars represent mean judgment scores and standard errors for the positively (90%) and negatively (10%) conditioned pattern on the Conditioned Pattern Preference Task for intoxicated ($n = 83$) and sober ($n = 69$) participants. There was no main effect of experimental group on judgment scores and no interaction effect between group and patterns.
conditioned patterns. A 3(test version) X 2 (group) X 2 (pattern) repeated-measures ANOVA showed a main effect of pattern ($F(1, 146) = 7.30, p < .01$) in that the mean judgment score for the 90% rewarded pattern was significantly higher ($M = 5.83, SE = 0.25$) than for the 10% rewarded pattern ($M = 4.85, SE = 0.24$). Alcohol had no effect on this measure (main effect of group $F(1, 146) = 0.04, p = .84$), and there was no pattern X group interaction ($F(1, 146) = 0.001, p = .98$). There was a main effect of test version ($F(2, 146) = 7.02, p < .01$), as well as a significant interaction between pattern and test version ($F(2, 146) = 21.20, p < .01$).

3.2.3 Gender effects

A 3 (version) X 2 (gender) X 2 (pattern) repeated-measures ANOVA showed no significant main effect of gender on the judgment scores for male and female participants ($F(1, 146) = 0.79, p = 0.38$). There was a main effect of test version ($F(2, 146) = 8.27, p < .01$), as well as a significant interaction between pattern and test version ($F(2, 146) = 18.60, p < .01$).

3.2.4 Explicit memory effects

A one-sample chi-square test was conducted to assess whether intoxicated and sober participants differed in their explicit knowledge of the task as verified by the Declarative Knowledge Questionnaire and shown in Figure 8. There was no significant difference between the intoxicated and sober groups when asked to identify the pattern that was most associated with reward (i.e. 90% pattern) ($\chi^2(1, N = 152) = 1.46, p = .23$), however, sober individuals were significantly more likely to recall the 10% reward pattern ($\chi^2(1, N = 152) = 8.31, p < .01$). When asked to guess which 3 of the 6 patterns were seen during the task, intoxicated participants were also less likely to guess the 3
Figure 8. The effect of treatment on explicit memory. Bars represent the percent of correctly identified patterns in the sober ($n = 69$) and intoxicated ($n = 83$) groups when participants were explicitly asked to identify which pattern was associated with 90% reward, which was associated with 10% reward and which 3 patterns (of 6) were shown on the task. There was no difference between the intoxicated and the sober group at identifying the 90% pattern, however, intoxicated individuals showed significantly fewer correct identifications of the 10% pattern as well as overall for the 3 patterns shown during the Formation phase.
correct patterns ($\chi^2(1, N = 152) = 7.84, p < .01$), yet they did not differ from sober participants when questioned on the certainty of their choices ($\chi^2 (4, N = 152) = 7.33, p = 0.12$).

A 2 (group) X 6 (block) repeated-measures ANOVA was used to examine performance on the counting task, where participants estimated the number of black balls they saw in each of the three boxes. This assessment of working memory was calculated by subtracting the sum of the number of black balls viewed at each trial block, from each participant’s estimate. These data are presented in Figure 9. There was a significant difference between the sober and intoxicated group ($F(1, 145) = 5.69, p = .02$) in that the intoxicated group had a higher overall mean error rate ($M = 6.16, SE = 1.35$, sober $M = 1.41, SE = 1.46$). A main within-subjects effect of block ($F(5, 725) = 13.73, p < .01$) showed that although there was no significant difference between trial blocks 1, 2 and 3, all of the subsequent trial blocks had significantly higher error rates ($p < .05$). There was also a group X block interaction ($F(5, 725) = 9.77, p < .01$), whereby the intoxicated group showed significantly higher error rates on each of the last 3 blocks of trials ($p < .01$) compared to the sober group.

3.2.5 Drug Use Questionnaire

The DUQ was completed by 66 participants and the results are displayed in Table 2. Forty-seven percent ($n = 31$) reported having a family member who experienced a drug or gambling problem and 50% ($n = 15$) of these were first degree relatives. Fifty-eight percent ($n = 38$) of participants reported having used recreational drugs other than alcohol, 15% on a regular basis.
Figure 9. The effect of treatment on working memory. Bars represent the mean error scores of participants on the counting task. Intoxicated individuals made significantly more errors on the task. Both sober and intoxicated individuals showed an increase in errors on each progressive trial block, however, intoxicated individuals showed the greatest increase in errors during the last 3 trial blocks.
Table 2
Participant responses on the Drug Use Questionnaire.

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has any family member experienced a drug and/or gambling problem?</td>
<td>47%</td>
<td>53%</td>
</tr>
<tr>
<td>First-degree family member?</td>
<td>22.7%</td>
<td></td>
</tr>
<tr>
<td>What was their drug of abuse?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Alcohol</td>
<td>28.8%</td>
<td></td>
</tr>
<tr>
<td>• Nicotine</td>
<td>13.8%</td>
<td></td>
</tr>
<tr>
<td>• Gambling</td>
<td>7.6%</td>
<td></td>
</tr>
<tr>
<td>• Cocaine</td>
<td>4.5%</td>
<td></td>
</tr>
<tr>
<td>• Marijuana</td>
<td>4.5%</td>
<td></td>
</tr>
<tr>
<td>Have you ever used recreational drugs?</td>
<td>57.6%</td>
<td>42.4%</td>
</tr>
<tr>
<td>• Marijuana</td>
<td>56.1%</td>
<td></td>
</tr>
<tr>
<td>• Mushrooms</td>
<td>10.6%</td>
<td></td>
</tr>
<tr>
<td>• Cocaine</td>
<td>6.1%</td>
<td></td>
</tr>
<tr>
<td>• LSD</td>
<td>6.1%</td>
<td></td>
</tr>
<tr>
<td>• Ecstasy</td>
<td>4.5%</td>
<td></td>
</tr>
<tr>
<td>• Pharmaceutical Opiates</td>
<td>3%</td>
<td></td>
</tr>
<tr>
<td>Do you use recreational drugs on a regular basis?</td>
<td>15.2%</td>
<td></td>
</tr>
</tbody>
</table>
Figure 10 displays the mean judgment scores for the 38 participants who reported recreational drug use and the 28 participants who did not report drug use. A 3 (version) X 2 (drug use) X 2 (pattern) repeated measures ANOVA revealed a significant difference between these two drug use groups ($F(1, 60) = 6.51, p = .02$) where the mean score for those who reported recreational drug use ($M = 4.79$) was lower than those who reported no recreational drug use ($M = 5.91$). There was no interaction between pattern and drug use group ($F(1, 60) = 1.95, p = .17$), however, a planned comparison showed a trend for a greater mean difference between the 90% and the 10% pattern scores in the group who did not report drug use ($p = .07$). There was a main effect of test version ($F(2, 60) = 7.18, p < .01$), as well as a significant interaction between pattern and test version ($F(2, 60) = 9.76, p < .01$).

A similar pattern was observed when family history of drug use rather than recreational drug use was used as a factor in a 3 (version) X 2 (family history) X 2 (pattern) repeated-measures ANOVA. These data are shown in Figure 11: 31 participants reported a family member with a drug/gambling problem and 35 did not. There was a main effect of test version ($F(2, 60) = 5.26, p < .01$), as well as a significant interaction between pattern and test version ($F(2, 60) = 9.44, p < .01$). There was a marginally significant main effect of family history ($F(1, 60) = 3.86, p = .054$), where the mean judgment score for those with a positive family history ($M = 4.78$) was lower than those who reported a negative family history of drug problems ($M = 5.62$). There was no interaction effect between pattern and family history group ($F(1, 60) = 1.11, p = .3$), however, a pairwise comparison revealed a marginally significant trend for the negative
Participants who reported recreational drug use did not demonstrate a preference for the 90% pattern.

Figure 10. Mean judgment scores for the positively and negatively conditioned patterns on the Conditioned Pattern Preference Task for participants who reported recreational drug use (n = 38) and those who did not (n = 28). Participants who reported recreational drug use did not demonstrate a preference for the 90% pattern.
Figure 11. Mean judgment scores on the Conditioned Pattern Preference Task for participants who report a positive family history of addiction (FH+; $n = 31$) and those who did not report a family history of addiction (FH-; $n = 35$). The FH+ group did no display a preference for the 90% pattern.
family history group to show a greater mean score difference between the 90% and the 10% patterns \( (p = .056) \).

The results of a one-sample chi-square test examining family history and individual reported drug use was significant \( (\chi^2(1, N = 66) = 6.61, p = .01) \). Seventy-four percent \( (n = 23) \) of those individuals who reported individual drug use, also reported a positive family history of drug problems. Concurrently, 71\% \( (n = 20) \) of those who did not report recreational drug use also reported no family history of drug problems.

3.2.5.1 Drug Use Questionnaire explicit memory effects

A one-sample chi-square test examined whether those who reported individual drug use differed from those who did not report drug use on their explicit memory of the task. Participants who reported drug use were significantly less likely to correctly identify all 3 patterns that were in the conditioning task \( (\chi^2(1, N = 66) = 4.86, p = .03) \). In contrast, there were no significant differences between these two groups on remembering which pattern was paired with 90\% reward, with 10\% reward or the certainty of their choices.

Participants who reported a positive family history of addiction were also less likely to correctly identify the 3 patterns used for conditioning \( (\chi^2(1, N = 66) = 3.96, p = .05) \), and a trend showed that they were also less likely to correctly identify the 90\% reward pattern \( (\chi^2(1, N = 66) = 2.83, p = .09) \). This group also rated themselves as less certain of their pattern choices \( (\chi^2(3, N = 66) = 10.54, p = .02) \) than the family history negative group, who were more likely to rate their choices as certain or quite sure.

3.2.5.2 Drug Use Questionnaire, personal drinking habits and subjective intoxication effects
The data from the personal drinking habits questionnaire (PDH) and the subjective intoxication effects questionnaire are displayed in Table 3. On the PDH, an ANOVA showed that individuals who reported recreational drug use also reported more drinking occasions per month ($F(1, 64) = 3.93, p = .05$) and a trend for these drinking occasions to last longer ($F(1, 64) = 3.13, p = .08$). They did not, however, differ in the average number of drinks consumed on drinking occasions ($F(1, 64) = .30, p = .58$).

There were no differences in personal drinking habits between those who reported a positive family history of drug addiction and those who did not.

A 2 (DUQ group) X 2 (experimental group) X 8 (estimated bottles) ANOVA from the DUQ, examined whether participants who reported drug use differed in their subjective ratings of intoxication. There were no significant differences between those who reported drug use and those who did not on their like/dislike of the intoxication effects that they felt, nor on their ratings of wanting more alcohol. There was, however, a significant difference between those who reported and those who did not report drug use on their estimation of the number of bottles of beer consumed ($F(1, 60) = 4.25, p < .05$), where those who reported drug use estimated that they had consumed significantly less alcohol than those who didn’t report drug use. There was also an interaction effect between DUQ group and experimental group ($F(1, 60) = 4.09, p = .05$) in that participants who reported drug use estimated having had significantly fewer bottles of beer when intoxicated than those who did not report drug use.

There was no difference on the DEQ between those who reported a family history of addiction and those who did not.
Table 3: Descriptives of the Drug Use Questionnaire with Personal Drinking Habits and Subjective Intoxication Effects.

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>Recreational Drug Use</th>
<th>No Reported Drug Use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>($n = 38$) Means (SD)</td>
<td>($n = 28$) Means (SD)</td>
</tr>
<tr>
<td><strong>Personal Drinking Habits</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Drinking Occasions per Month</td>
<td>6.4 (4.0)*</td>
<td>4.6 (2.6)*</td>
</tr>
<tr>
<td>Length of Drinking Occasions (Hours)</td>
<td>4.7 (1.3)</td>
<td>4.2 (1.3)</td>
</tr>
<tr>
<td>Number of Drinks Consumed</td>
<td>5.3 (3.2)</td>
<td>4.9 (2.1)</td>
</tr>
<tr>
<td><strong>Subjective Intoxication Effects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimated number of bottles of beer ingested</td>
<td>3.7 (2.2)*</td>
<td>3.8 (2.9)*</td>
</tr>
<tr>
<td>Estimated number of bottles of beer ingested (intoxicated)</td>
<td>5.4 (1.1)*</td>
<td>6.7 (1.6)*</td>
</tr>
<tr>
<td>Estimated number of bottles of beer (placebo)</td>
<td>1.6 (1.2)</td>
<td>1.7 (.9)</td>
</tr>
<tr>
<td><strong>Alcohol Expectations</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive Expectations</td>
<td>60.8 (7.6)*</td>
<td>54.0 (8.6)*</td>
</tr>
<tr>
<td>Liquid Courage</td>
<td>14.9 (2.6)*</td>
<td>12.8 (2.5)*</td>
</tr>
<tr>
<td>Sexuality Expectations</td>
<td>10.7 (2.8)**</td>
<td>8.0 (2.6)**</td>
</tr>
</tbody>
</table>

*p < .05

**p < .01
3.2.6. Novelty and familiarity effects

A 2 (group) X 2 (pattern) repeated measures ANOVA examining the difference between the 3 (‘familiar’) patterns viewed during the conditioning task and the 3 novel patterns shown during the Judgment phase showed no significant difference between the 83 intoxicated and the 69 sober participants ($F(1, 150) = 1.33, p = .25$). There was a main effect of pattern in that both groups significantly preferred the familiar patterns over the novel ones ($F(1, 150) = 19.97, p < .01$).

Similarly, a 2 (group) X 2 (pattern) repeated measures ANOVA examining familiarity effects for the 38 participants who reported recreational drug use and the 28 that reported no recreational drug use showed no significant difference between the two groups ($F(1, 64) = 1.37, p = .25$), with both displaying a preference for the familiar patterns ($F(1, 64) = 5.30, p = .03$). Examining family history of addiction in a 2 (group) X 2 (pattern) repeated measures ANOVA showed a slight trend for the family history positive group to select more of the novel patterns ($F(1, 64) = 3.13, p = .08$), however, there was still overall a main preference for the familiar patterns ($F(1, 64) = 4.27, p = .04$).

3.2.7 Barratt Impulsiveness Scale

The grand mean on the BIS for the 66 participants who completed the questionnaire was 62.17 ($SE = 1.28$). There were no significant differences, either in the total BIS scores or in scores on the 3 subscales, between experimental groups (sober and intoxicated), individuals reporting recreational or no recreational drug use, or those reporting a family history or no family history of drug/gambling problems.

3.2.8 Comprehensive Effects of Alcohol
There were no significant differences between the sober or intoxicated groups for either expectations or evaluations on the CEOA.

Three one-way ANOVAs showed that participants who reported individual drug use showed significantly different expectations of alcohol. These participants had a mean higher score for overall positive expectations of alcohol ($F(1,33) = 5.71, p = .02$), as well as for the Liquid Courage Subscale (eg. “I would feel powerful”) ($F(1,33) = 5.29, p = .03$), and for Sexuality Expectations (eg. “I would be a better lover”) ($F(1,33) = 7.66, p < .01$). There was no significant difference between groups on their evaluations of alcohol. There was no significant difference in expectations or evaluations on the CEOA between individuals who reported a family history of addiction and those who did not.

3.3 Discussion

The main findings from the study are summarized in the following points: 1) Alcohol intoxication did not disrupt implicit conditioning on the CPP task, 2) Alcohol intoxication did disrupt explicit memory for task stimuli as well as working memory, 3) Recreational drug use and a positive family history of addiction (FH+) were associated with a lack of preference formation on the CPP task, as well as explicit memory deficits for task-related stimuli. The CPP is a task with very low demand awareness; when participants were questioned on why they preferred or disliked particular patterns, 82% attributed their preferences to physical characteristics of the pattern, rather than the experimental contingencies during the Formation phase of the task. When asked to identify the task-related patterns, the intoxicated group demonstrated explicit memory deficits, yet when questioned on the certainty of their choices, this group did not differ from the sober group, thereby indicating a lack of awareness in the former for their
memory deficits. These results are consistent with other studies showing a dissociation in the effects of alcohol on implicit and explicit memory processes (Kirchner and Sayette, 2003; Lister et al., 1991; Tracy and Bates, 1999), whereby acute intoxication disrupts explicit memory, while leaving implicit memory intact. The progressive increase in cognitive estimation errors on the counting task displayed by the intoxicated group demonstrates a reduced capacity in error-monitoring. The inaccurate monitoring of error contingencies is further demonstrated by this group’s inability to identify stimuli associated with non-reward, as well as task stimuli in general. These results concur with evidence that moderate doses of alcohol cause error-detection impairments that were related to decreased brain activity of the anterior cingulate cortex (Ridderinkhof et al., 2002). Our findings also show a deficit in action-monitoring caused by alcohol whereby the intoxicated group’s impoverished attention resulted in a reduced ability to learn environmental cues.

The CPP task presents an innovative approach to studying conditioned learning because it effectively separates contingency knowledge from associative learning. In the CPP, individuals displayed an emotional response as well as an attentional bias (choosing a pattern more frequently, describing pleasing physical characteristics of the pattern) to an external stimulus predictive of reward (90% pattern), without explicit awareness of the conditioning procedure. Less than 18% of the participants who completed the CPP explicitly related their pattern preferences to the experimental contingencies. The lack of awareness of the conditioning procedure on the CPP can be explained by a number of factors including a) volunteers are engaged on a cognitively demanding “cover” task (monitoring the frequency of occurrence of black balls) which is irrelevant to the
patterns, which are not mentioned to the subjects. b) the reward-pattern pairings are not completely consistent – on 10% of the trials on which they are present, the most rewarded pattern is paired with nonreward, and the least rewarded pattern is paired with reward. Also, although the preference score for the 90% pattern was significantly greater than for the 10% pattern and for chance (5) it was not very high, and many volunteers chose at least one other pattern more frequently than they chose the 90% pattern. The mean preference score for the 10% pattern was close to 5, or chance, demonstrating a lack of preference for this pattern but not an aversion. These findings are consistent with incentive-sensitization theory, whereby individuals gradually develop an increasing attentional bias to cues predictive of reward (Robinson & Berridge, 1993). Although other studies have reported that conscious awareness is necessary for conditioning to occur (Hogarth & Duka, 2006; Hogarth et al., 2005), these studies used an addicted population and involved quite different paradigms, some with aversive learning. Our study, using non-addicted individuals, demonstrated subtle, implicit preference formations for cues predictive of reward.

The lack of significant difference between preference formation in the sober and the intoxicated group, however, demonstrates that the 90% pattern was not more salient to the intoxicated group, perhaps because the discriminative contingencies of the CPP were too low. The dissociation between implicit and explicit learning in acutely intoxicated individuals appears to be a robust finding, suggesting that future research should begin to examine individual factors that play a role in implicit learning.

The DUQ revealed unexpected results related to performance on the CPP task. The FH+ group and those individuals reporting recreational drug use overlapped
significantly, in that 74% of individuals in the FH+ group reported recreational drug use. This is the first experiment, to our knowledge, to find an association between recreational drug use, positive family history of addiction and implicit learning in healthy individuals. Reports from the positive recreational drug use group regarding their drinking habits, drinking expectations and intoxicated perceptions provide some evidence of behavioural disinhibition when compared to those who do not report drug use. On the PDH, the recreational drug use group reported a trend of more drinking occasions per month, and drinking for longer periods of time, although this did not reach statistical significance. In the lab, the recreational drug use group estimated having consumed significantly less alcohol when intoxicated than those who did not report drug use. Also, this group reported overall greater positive expectations of alcohol, including courage and sexual expectations. Our study did not include any measures of mood, such as the Beck Depression Inventory. In future studies, we will examine whether the recreational drug use and the FH+ groups also differ in affect regulation, given the high rates of comorbidity between substance abuse and mood disorders (Conway et al., 2006).

Before discussing the implications of these findings further, several limitations must be addressed. The DUQ is a self-report measure used in our studies to collect background information on participants’ drinking and drug use, and is not a standardized test. Our inclusive criteria for the FH+ and the recreational drug use group were very broad: we included all family reports of drug problems, including great uncles and cousins into the FH+ group. Likewise, we included all individuals who reported recreational drug use, including those who used multiple ‘harder’ drugs, such as cocaine and ecstasy, as well as those who reported only smoking marijuana once or twice in their
lives. A greater sample and more specific questionnaire will allow a closer examination of these groups in the future. It is also possible that the sensitive nature of material on the DUQ caused some individuals to underreport familial addiction problems or their own personal drug use. These participants would then be miscategorized as FH- or negative drug use, thereby increasing the chances of a Type II statistical error. At the same time, our rates of self-identified children of alcoholics (COAs) and reported rates of recreational drug use are consistent with rates in other college populations (Berkowitz and Perkins, 1988; Sher et al., 1991; Adlaf et al., 2003; McCabe et al., 2007).

In our experiment, individuals at risk for addiction, through drug experimentation and/or through a positive family history of addiction, demonstrated altered preference formation on an implicit learning task recruiting the motivational neurocircuitry necessary for adaptive decision-making. Our results showed that these individuals displayed deficits in affective learning, whereby they did not demonstrate learning for a cue predictive of reward. The absence of implicit learning demonstrated by the FH+ group and those who reported recreational drug use suggests that the contingencies were not sufficiently robust to influence responding. It is possible that these individuals may have required more explicit contingencies or awareness in order to demonstrate conditioning. The explicit memory impairments demonstrated by both the FH+ and the recreational drug use groups support the idea that the task-related stimuli may have been less salient to them. The failure of stimuli to acquire affective properties in these groups is suggestive of decreased activity in the motivational neurocircuitry necessary for coding the intrinsic value of stimuli. Chronic underarousal in this system would render an individual more likely to seek out greater rewards, consistent with the profile of
sensation-seeking and behavioural undercontrol described in individuals at high risk for alcoholism (Cloninger, 1987).

Research into factors of addiction vulnerability has focused predominantly on alcohol, particularly children of alcoholics. This research has been criticized for an over reliance on clinical samples of COAs who themselves abuse alcohol (Havey and Dodd, 1993), to the exclusion of COAs who are free of pathology. The use of a university sample with a family history of addiction represents a unique population that demonstrates adaptive behaviours (through their academic success), yet simultaneously is at an age and in an environment associated with binge drinking and drug experimentation during a time that drinking problems are likely to emerge (Havey and Dodd, 1993). The predominant use of clinical populations in drug research makes it difficult to study whether any behavioral differences reflect inherent pathogenesis or are the consequence of chronic drug exposure. Our use of a healthy, successful group of young adults effectively separates risk factors from drug abuse consequences.

Although our study did not use validated prescreening measures to establish family history of addiction, the self-report rates of addiction and recreational drug use are consistent with results of other studies. The significant difference in implicit learning in the FH+ and positive recreational drug use groups, despite our liberal inclusion criteria, lends further support to these findings. The significant overlap between individuals who report a family history of addiction and who themselves report recreational drug use is also noteworthy. Further research with more precise diagnostic criteria will better differentiate the groups, the mechanisms and the neural substrates of affective learning in populations at risk for substance abuse.
Foreword to Chapter 4

Chapter 4 consists of a manuscript submitted to *Psychoneuroendocrinology*. K. Wynne-Edwards and M.C. Olmstead are co-authors on the paper.
Chapter 4:

Cortisol reactivity, alpha-amylase and risk-taking after acute alcohol intoxication

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Abstract

Few laboratory studies have examined stress-intoxication interactions in healthy individuals. Biological indicators of stress include increases in cortisol and alpha-amylase (AA), markers of hypothalamo-pituitary-adrenal (HPA) axis and sympathoadrenal medullary activity respectively. This experiment used both biological and self-report measures to examine the interaction between psychosocial stress and alcohol intoxication and how these affect risk-taking in healthy young adults. Following the Trier Social Stress Test (TSST), participants completed a risk-taking task. Exposure to the TSST significantly increased salivary cortisol and AA, as well as subjective self-ratings of anxiety and tension. Individuals in the placebo and the intoxicated groups reported less tension and anxiety following the TSST and did not show the same increase in cortisol as the sober group. In addition, intoxicated individuals who reported high-tension levels showed increased risk-taking compared to intoxicated individuals with lower tension levels. Higher cortisol and AA levels following the stressor were associated with advantageous performance on the risk-taking task, suggestive of greater motivation as well as sensitivity to reward and punishment in this group. Taken together, these findings show that individual patterns of stress reactivity may be more important than alcohol as a determinant in the motivational balance between reward sensitivity and punishment avoidance.

Keywords: Psychosocial stress; Cortisol; Alpha-amylase; Alcohol; Risk-taking; Reward
4.0. Introduction

Acute stress is linked to increased vulnerability to substance abuse, increased drug consumption, and is a major contributor to drug relapse, although the precise mechanism by which stress mediates these effects is not known (Sinha, 2001). The idea that alcohol may alleviate stress while simultaneously increasing risk-taking behaviour is frequently depicted in films: a distraught protagonist enters a bar, orders a strong drink (or three), leaves drunk and goes on to show more reckless behaviour. Unlike the movies, however, the stress-response-dampening effects of alcohol in the lab are equivocal. Using changes in cortisol levels as a physiological indicator of stress, alcohol intoxication may increase (Schuckit, Gold & Risch, 1987), decrease (Waltman, Blevins, Boyd & Wand, 1993) or have no effect (Davis & Jeffcoate, 1983) on stress responses. Although several theories attempt to explain the differential effects of alcohol on stress, none can fully account for the ambivalent findings reported in lab settings (Josephs and Steele, 1990; Sayette, 1993).

Identifying whether alcohol intoxication alters stress reactivity has implications for understanding a number of disorders, particularly those that are characterized by risk-taking behaviours. For example, substance abusers without co-morbid psychiatric disorders and heavy social drinkers both exhibit blunted hypothalamic-pituitary-adrenal (HPA) axis responses to alcohol (Lovallo, Dickensheets, Myers, Thomas & Nixon, 2000; King, Munisamy, de Wit & Lin, 2006). Individuals with Attention-Deficit-Hyperactivity Disorder and children of alcoholics also show blunted cortisol responses and a propensity to engage in risky behaviours (King, Barkley & Barrett, 1998; Sorocco, Lovallo, Vincent & Collins, 2006). In healthy individuals, low cortisol levels are related to punishment
insensitivity and reward dependency, two characteristics that increase risk-taking (van Honk, Schutter, Hermans & Putman, 2003).

An interaction between stress reactivity and alcohol intoxication may explain why the effect of alcohol on risk-taking is so difficult to establish in the lab. Some studies report increased risk-taking in intoxicated individuals (Lane, Cherek, Pietras & Tcheremissine, 2004; George, Rogers & Duka, 2005), some report that intoxicated participants perform less impulsively (Ortner, MacDonald & Olmstead, 2003), whereas others report no effect of alcohol on impulsivity and risk-taking in a decision-making task (Balodis, MacDonald & Olmstead, 2006). Although stress levels were not specifically manipulated in these studies, testing participants in lab settings is very likely to increase hormonal markers of stress, at least in some individuals. The apparent discrepancies in results, therefore, may be explained by individual differences in stress responsivity which then interact with behavioural measures such as risk-taking.

The purpose of the following experiment was to understand the relationship between alcohol intoxication, stress and risk-taking. In a controlled experimental setting, we tested the hypothesis that individuals who show greater stress reactivity (increases in cortisol, alpha-amylase (AA) and self-report anxiety levels in response to a stressor) are more likely to take risks, and that this behaviour will be moderated by alcohol. Healthy participants was examined in order to establish the role of stress on alcohol-induced risk-taking in the absence of any pathology. Risk-taking was assessed using self-report measures and a computerized task. Changes in salivary cortisol provided a standard measure of stress reactivity. We also examined changes in AA levels as a surrogate
marker for sympathetic activity. This protein can be detected noninvasively and acts as an index of sympathoadrenal medullary system (SAM) activity, an extra-hypothalamic stress response system activating norepinephrine (Chatterton, Vogelsong, Lu, Ellman & Hudgens, 1996). Like cortisol, AA levels increase following acute stressors and have a distinctive circadian rhythm (Rohleder, Nater, Wolf, Ehlert & Kirschbaum, 2004). Alcohol intoxication decreases salivary AA levels (Enberg, Alho, Loimaranta & Lenander-Lumikari, 2001), however, to date no study has examined the interaction of stress and alcohol on AA.

In line with previous work (Lane et al., 2004), we predicted that alcohol would increase risk-taking in a computer-simulated task. Given that low cortisol levels are associated with greater impulsive choice and reward dependency (van Honk et al., 2003; Takahashi, 2004), we also hypothesized an inverse relationship between stress reactivity and risk-taking. Namely, individuals with the greatest change in biological stress markers (i.e. cortisol and AA) following a stressor would demonstrate less risk-taking. Conversely, individuals with lower stress reactivity would demonstrate increased risk-taking and alcohol would enhance this effect.

4.1 Methods

4.1.1 Participants

Participants were 87 healthy undergraduate students (29 males, 58 females) from Queen’s University, recruited through classes and a student volunteer subject pool. Eligibility criteria for the study included that the participant 1) reported no allergic reactions to alcohol; 2) had no medical conditions that contraindicated alcohol; and 3)
reported consuming alcohol at least once per month. The age of participants ranged from 19 to 27 years with a mean age of 20. To ensure minimal risk of pregnancy, females were tested only during menstruation or, if they had not had sexual intercourse since their last menstrual cycle. All participants were asked not to eat for 3 hours prior to the experiment and all were tested between the 14:00 and 19:00. Course credit, or an honorarium of $10 was awarded to all participants upon completion of the experiment. In addition, participants were allowed to keep money earned on the risk-taking task. This experimental protocol was approved by the General Research Ethics Board of Queen’s University.

4.1.2 Measures

4.1.2.1 Self-report measures

The Barratt Impulsiveness Scale

The Barratt Impulsiveness Scale (BIS), version 11, was used as a self-report measure of individual impulsive traits. The BIS is a 30-item questionnaire with Nonplanning, Motor and Cognitive Impulsiveness subscales. Participants rate themselves on statements using a 4-point scale: rarely/never, occasionally, often or almost always. All the items on the BIS are moderately correlated with each other and the scale shows a high test-retest reliability (Patton et al., 1995; Fossati et al., 2001).

Personal Drinking Habits

This self-report questionnaire contains questions regarding an individual’s drinking habits, including the frequency, amount and length of drinking occasions.

Drug Use Questionnaire (DUQ)
This self-report questionnaire contains questions regarding an individual’s drug use history and that of their family. The DUQ also collects information regarding the type of drug and frequency of drug use. The last 5 questions are adapted from the South Oaks Gambling Questionnaire (Lesieur & Blume, 1987) examining the type and frequency of gambling behaviour.

*Comprehensive Effects of Alcohol Questionnaire*

The CEOA is a comprehensive measure of discrete alcohol expectancies, including both positive and negative factors (Fromme et al., 1993). The self-report questionnaire consists of 38 statements, first examining an individual’s expectation as to whether they are under the influence of alcohol using a 4-point Likert scale. These same 38 statements are then subjectively evaluated on a 5-point Likert scale, in which the individual rates the particular effect as good, bad or neutral. These statements have been categorized into domains of Sociability, Tension Reduction, Liquid Courage, Sexuality, Cognitive and Behavioural Impairments, Risk and Aggression and Self-Perception. The CEOA demonstrates good test-retest reliability as well as construct and criterion validity (Fromme et al., 1993).

*Profile of Mood States*

The Profile of Mood States (POMS; McNair et al., 1988) is a self-report adjective checklist of 65 items, rating current mood states. The mood dimensions are measured on six subscales: tension-anxiety (0-36 raw score range), depression-dejection (0-59 raw score range), anger-hostility (0-44 raw score range), vigour-activity (0-31 raw score range), fatigue-inertia (0-28 raw score) and confusion-bewilderment (0-28).
tension-anxiety scale, which consists of such items as ‘tense’, ‘on edge’ and ‘nervous’ has been shown to be a valid measure of psychosocial stress.

*Kurz-Skala Stimmung/Aktivierung*

The Kurz-Skala Stimmung/Aktivierung or KUSTA (Wendt, Binz & Mueller, 1985), is a visual analogue scale with a 17-point bipolar scale for mood (depression/happiness), activity (tired/fresh), and tension (irritable/relaxed) and unipolar ratings for joy, anxiety, anger and disappointment (not at all/extreme). This measure was used to assess the mood state of participants prior to and immediately following the psychosocial stressor.

*Manipulation Check*

Following the second session of the risk-taking task, participants completed a manipulation check self-report measure to examine the perceived level of intoxication and to judge the effectiveness of the placebo manipulation.

*4.1.2.2 Physiological Measures*

*Breathalyzer*

Blood alcohol concentrations were estimated through the BAL using the Intoxilyzer 400D, a handheld breath alcohol testing instrument. Participants blew air through a mouthpiece into a fuel cell which measured the alcohol concentration in the expired breath.

*Salivary cortisol & alpha-amylase*

Saliva samples for cortisol and alpha-amylase measurement were collected by having participants passively drool through a short straw into a polypropylene vial. No
saliva flow stimulant was used. The samples were capped, labeled and frozen at -20°C in a non-self-defrosting freezer. Assays were completed using an expanded range high sensitivity salivary cortisol enzyme immunoassay kit (Salimetrics, State College, PA) and a salivary α-amylase assay kit (Salimetrics, State College, PA) to determine free cortisol and α-amylase concentrations in the samples.

4.1.2.3 Behavioural Measures

4.1.2.3.1 Risk-Taking Task

The Risk-Taking Task is a computer task on which intoxicating levels of alcohol have been shown to dose-dependently increase risky choices (Lane, Cherek, Pietras & Tcheremissine, 2003). The task consists of a two-choice procedure in which participants choose between two panel buttons, associated with risky and non-risky payoffs. Option A is the risky choice, associated with gains or losses of $0.25, $0.50, $0.75 or $1.00 equiprobable on each trial. Option C is considered non-risky, with each trial producing a gain of $0.02. After reading the instructions for the task, participants completed a 50-trial training session. Following the psychosocial stressor, participants completed a 100-trial session of the task. To increase motivation on the task, participants were informed that they could keep the money they earn on the second (100-trial) session of the task.

4.1.3 Procedures

4.1.3.1 Psychosocial Stressor

Psychosocial stress was induced by having participants perform the Trier Social Stress Test (TSST) in which the individual is asked to perform tasks in front of an audience (Kirschbaum, Pirke & Hellhammer, 1993). In the first stage of the task, the participant entered a different room in which a panel of 3 people was introduced to them.
The participants were told that they had 10 minutes to prepare a 5 minute mock-job talk for a position as a research assistant. To increase anticipatory stress, the participants were told that their speech would be videotaped and that one of the panel members, trained to monitor nonverbal behaviour, would later examine body language and do a voice frequency analysis of the taped session. During the 10-minute preparatory time, participants were provided with a pen and paper to outline their talk, however, just before giving the speech, any written notes prepared were taken by one of the panel members and the individual was told that their written concepts would be compared to the actual content of the presentation. Participants were then asked to stand on an ‘X’ marked on the floor and deliver the speech with the video camera set to record mode and the LCD monitor rotated around so that the participant could also see their own face in the frame. The participant faced the panel members who each had a clipboard and took notes while the speech was delivered. If the participant finished before the 5 minutes were up, they were informed by the panel member holding a stopwatch that they still had X minutes left. If the participant had nothing left to say, following a 10 second pause, the panel members began to ask prompting questions such as “What personality characteristics are important for working in a lab environment?” or “How have your grades been this past year?”

Following the presentation (time + 15 min), participants were told that they would be required to perform one more task to verify their alertness, but not to worry because the task was very easy and most people had no problems with it. The mental arithmetic component lasted 5 minutes in which participants were asked to serially subtract prime numbers from four digit numbers (e.g. 1223 by 17) as quickly and as accurately as
possible. If the participant made a mistake, they were corrected and asked to start again from a different number. After 5 minutes, participants were thanked and sent back to the laboratory.

The TSST lasted 20 minutes and reliably activates HPA axis activity, including an increase in salivary cortisol levels in humans (Kirschbaum et al., 1993). Cortisol levels usually return to baseline within 90 minutes.

4.1.4 No-stress control condition

In the no-stress control condition, the experimental protocol was identical, with the exception that these individuals completed crossword puzzles for 20 minutes, instead of the TSST.

4.1.5 Alcohol Administration

This study followed the protocol of alcohol administration previously used in our laboratory to examine the effects of alcohol on computer tasks (Balodis, MacDonald & Olmstead, 2006; Balodis, Johnsrude & Olmstead, 2007). Participants were weighed at the beginning of the session so that each participant would receive the same dose of alcohol. The intoxicated group received 3 alcoholic drinks consisting of a 2:1 ratio of Fresca soda to Vodka (40% alcohol), so as to raise their BAL to .08%, the legal limit in Ontario. Participants in the placebo group were told that they were receiving alcohol, although their drinks consisted only of Fresca soda mixed with flattened tonic water. The glasses of the placebo group were also rimmed with alcohol, so as to convincingly smell of alcohol when lifted to drink, without affecting the BAL of the participants. The control group received 3 drinks of Fresca soda and was informed that they were not receiving
alcohol. Participants watched two episodes of ‘The Simpsons’ (totaling ~45 minutes) while consuming the drinks. The appropriate alcohol mixture was divided into 3 glasses, each consumed at 10-15 minute intervals. Prior to beginning the task, individuals in the placebo and intoxicated groups had their BAL measured using a Breathalyser. A graphical representation of the procedure and all of the experimental tasks is presented in Figure 12.

4.1.6 Statistical Analyses

Data was analysed using SPSS version 14.0 for Windows. These statistical analyses confirm a normal distribution of the data as well as homogeneity of variance. Statistical significance was set at a probability of $p < .05$. The dependent measures were analysed as follows:

**The Barratt Impulsiveness Scale**

Participant’s ratings on the BIS were summed according to those methods recommended by Patton and colleagues (1995). This includes a total BIS score as well as scores for the motor, nonplanning and cognitive impulsivity subscales. These scores were correlated with risk-taking behaviour on the task as well as with cortisol and alpha-amylase levels. All correlational analyses were performed using Pearson correlations.

**Drug Use Questionnaire**

Answers from questions on the DUQ were dichotomously scored as yes/no for family history and recreational drug use and accordingly individuals were divided into positive or negative groups (i.e. positive/negative family history and recreational/no recreational drug use). These data were analyzed in repeated-measures ANOVA for risk-
Figure 12. Graphical representation of experimental tasks and timeline. Self-Report Measures = Barratt Impulsiveness Scale, Personal Drinking Habits, Drug Use Questionnaire, Comprehensive Effects of Alcohol Questionnaire; POMS = Profile of Mood States; KUSTA = Kurz-Skala Stimmung/Activierung; BAL = Blood Alcohol Level
taking scores using group as a between-subjects factor and risk-taking score as a within-subjects factor.

A one sample chi-square tests was used to examine the relationship between family history and recreational drug use.

To examine the relationship between the PDH and subjective effects of intoxication, positive and negative groups were used as fixed factors in ANOVAs with the personal drinking history and intoxication ratings as dependent factors.

*Comprehensive Effects of Alcohol Questionnaire*

Scores from the CEOA were tallied and divided into the 7 different subscales previously described as well as the positive and negative expectations recommended by Fromme and colleagues (1993). Scores on the CEOA were used as dependent measures in one-way ANOVAs with family history and recreational drug use from the DUQ as fixed factors.

*POMS and KUSTA ratings*

Scores from the POMS and KUSTA were correlated with cortisol levels as well as with scores on the risk-taking task.

*Salivary cortisol and alpha-amylase*

Salivary cortisol and alpha-amylase levels were analyzed using a repeated-measures ANOVA with experimental group as the between-subjects factor and time (pre- or post-stressor) as the within-subjects factor. Cortisol and alpha-amylase levels are reported as the percent change in cortisol levels in order to minimize the effect of individual differences and focus on the change of hormone levels, rather than the absolute values.
**Risk-Taking Task**

Participants completed the Risk-Taking Task prior to drinking and the difference score between this session and the second session (following drinking and the stressor) were used to assess differences in risk-taking behaviour. Risk-taking on the task was measured on a trial by trial basis by calculating each trial (N) in which the risky option was chosen and reinforced, followed by another selection from the risky deck in which the response was penalized (N+1). The number of penalized responses following the initial loss was calculated for the five subsequent trials as an index of how willing a participant is to continue to risk losing money. Other behavioural measures included the total number of choices made from the risky deck, overall response rate and earnings on the task.

The number of risky choices was used as the dependent variable in a 2 (group) X 2 (session) repeated-measures ANOVA, examining whether the mean number of risks taken was significantly higher following the stressor. This analysis was also used to determine whether there was a main effect of alcohol or stress on risk-taking, or an interaction between the two.

**Drug Effects Questionnaire and Manipulation Check**

Subjective ratings examining perceived intoxication effects were analysed with one-way ANOVAs with the subjective rating as the dependent factor and either experimental group, drug use group, or family history as a fixed factor. Ratings on these scales were also correlated with cortisol and alpha-amylase levels.

**4.2 Results**

**4.2.1 Manipulation Check**
4.2.1.1 Alcohol effects

The intoxicated group had a mean BAL of 0.092 (SD = .04), therefore the experimental manipulation to raise the BAL of participants to 0.08 was successful. Seventy-four individuals completed the Manipulation Check. Three separate one-way ANOVAs were used to confirm the effectiveness of the placebo manipulation. Sober, placebo and intoxicated groups differed significantly in their ratings of feeling sober or drunk \([F(2, 71) = 42.54, p < 0.001]\), in their estimates of bottles of beer consumed \([F(2, 71) = 57.69, p < 0.001]\), and in their ratings of alcohol content in the drinks \([F(2, 71) = 30.84, p < 0.001]\). A Bonferroni post-hoc comparison showed that the experimental groups differed in a stepwise fashion; the placebo group always rated themselves significantly higher than the sober group, but not as high as the intoxicated group.

4.2.1.2 Alcohol and subjective effects

Eighty-four individuals completed the POMS and the KUSTA. Subjective mood ratings on the POMS revealed, in multiple ANOVAs, significant differences between the 3 experimental groups on the subscales of Vigour \([F(2, 81) = 12.82, p < .001]\), Confusion \([F(2, 81) = 6.84, p < .01]\), Friendliness \([F(2, 81) = 3.2, p < .05]\), and Elation \([F(2, 81) = 15.39, p < .001]\). A post-hoc multiple comparison showed that the sober and placebo groups differed from the intoxicated group, in that the latter reported significantly greater levels of Vigour \((M = 18.51, \text{sober} = 12.41; \text{placebo} = 11.77)\), Friendliness \((M = 21.2; \text{sober} = 18.14; \text{placebo} = 17.95)\) and Elation \((M = 14.27; \text{sober} = 9.36; \text{placebo} = 8.95)\). Placebo \((M = 3.34)\) and intoxicated \((M = 4.2)\) groups reported significantly higher levels of confusion than the sober group \((M = 0.91)\).
Subjective mood ratings on the KUSTA revealed, in multiple ANOVAs, a significant difference between the 3 experimental groups only on the subscale of anxiety $[F(2, 81) = 3.13, p = .049]$. A post-hoc test showed that only the placebo group had slightly lower ratings ($M = 12.52$) than the intoxicated group ($M = 14.66; p = .03$).

4.2.2 Physiological Measures

4.2.2.1 Cortisol

Participants provided their first saliva sample immediately after signing the consent form, approximately 2 minutes after entering the laboratory. The second saliva sample was provided approximately 1 hour later after sitting and consuming drinks. Cortisol levels declined from sample 1 to sample 2 (Figure 13). Specifically, a one-way repeated-measures ANOVA revealed a significant within-subject difference between cortisol levels at these two times $[F(1, 86) = 21.32, p < .001]$. Sample one ($M = 0.17, SD = 0.15$) was significantly higher than the second sample ($M = 0.10, SD = 0.09$). Because participant’s levels do not appear stable until the second measurement and drink consumption occurred just prior to the second sample, this value was used as a baseline measure for subsequent analyses.

4.2.2.2 Alpha-amylase

In contrast to cortisol, alpha-amylase increased across samples (Figure 14). A one-way repeated-measures ANOVA showed a significant difference in alpha-amylase rates from sample 1 to sample 2 $[F(1, 82) = 14.39, p < .001]$. In order to be consistent with cortisol measures, sample 2 was used as baseline measure.
Figure 13. Change of cortisol level from sample 1 to sample 2. Participants \((N = 87)\) showed a significant decrease in cortisol levels from the time of entering the lab to one hour later.
Figure 14. Change in alpha-amylase levels from sample 1 to sample 2. Participants ($N = 83$) showed a significant increase in alpha-amylase levels from sample 1 to sample 2.
Two one-way ANOVAs showed no difference in cortisol \[ F(2, 80) = 0.04, p = .96 \) or alpha-amylase levels \[ F(2, 80) = 0.26, p = .77 \) in the sober, placebo and intoxicated groups following drink consumption.

### 4.2.3 Stressor Effects

#### 4.2.3.1 Subjective Effects

In contrast to alcohol, the TSST manipulation induced a robust stress response. One-way ANOVAs revealed that, relative to the no-stress control group \((n = 34)\), participants in the stress condition \((n = 49)\) reported significantly higher scores on the POMS subscales of Anxiety \([F(1, 78) = 16.99, p < .001]\), Depression \([F(1, 78) = 6.47, p = .013]\), Anger \([F(1, 78) = 6.16, p < .015]\), Confusion \([F(1, 78) = 16.01, p < .001]\) and lower scores on Elation \([F(1, 78) = 4.97, p = .029]\). Relative to their own pre-stress ratings on the POMS, eight paired t-tests revealed that participants in the stress condition demonstrated significantly higher scores on Anxiety \(t = -6.84, p < .001\), Depression \(t = -4.13, p < .001\), Anger \(t = -4.91, p < .001\), Confusion \(t = -4.65, p < .001\) and significantly lower scores on Vigour \(t = 3.74, p < .001\), Friendliness \(t = 4.38, p < .001\) and Elation \(t = 5.3, p < 0.001\). On the KUSTA, 6 paired t-tests revealed that individuals in the stress group reported significant increases in Tension \(t = 4.17, p < .001\), Anxiety \(t = 3.84, p < .001\) and Anger \(t = 2.98, p < .01\) and decreases in Mood \(t = 4.17, p < .001\), Activity \(t = 2.24, p < 0.05\), and Happiness \(t = 5.75, p < .001\).

#### 4.2.3.2 Physiological Effects

Changes in hormone levels were examined using two-way repeated-measures ANOVAs with sample (2 versus 3) as a within-subject variables and stress condition as a
between-subjects measure. This analysis revealed no main effect of sample \(F(1, 84) = 0.69, p = .41\), and no main effect of stress \(F(1, 84) = 0.97, p = .33\), however the interaction between sample and stress was marginally significant \(F(1, 84) = 3.42, p = .068\). Mean cortisol levels increased in the psychosocial stress group \((M = 0.16, SD = 0.36)\) compared to the no-stress control group \((M = 0.08, SD = 0.06)\). In order to focus on relative hormonal changes and control for individual differences in absolute levels, cortisol and alpha-amylase changes were assessed as a percent change from baseline levels. A one-way ANOVA with stress as a between-subjects variable revealed a significant difference in cortisol levels \(F(1, 84) = 9.74, p < .01\). The stress group demonstrated a mean increase from baseline of 40.55\% \((SD = 103.83)\) following the psychosocial stressor, while the no-stress group showed a mean 14.75\% decrease in cortisol levels \((SD = 26.05)\) during the same period.

A univariate ANOVA examining cortisol response to the psychosocial stressor in the stress group found a difference between males and females \(F(1, 48) = 4.12, p < .05\), where males showed a greater percent change cortisol response \((n = 11; M = 94.95, SD = 123.88)\) than females \((n = 39; M = 25.2, SD = 93.61)\). There were no other gender differences on any of the measures.

An ANOVA on alpha-amylase levels also revealed a main effect of session \(F(1, 80) = 7.11, p < .01\), a main effect of stress \(F(1, 80) = 9.42, p < .01\) and a significant interaction between the two \(F(1, 80) = 15.76, p < .001\). Alpha-amylase levels were significantly higher following the stressor \((M = 143.42, SD = 111.24)\) than at baseline \((M = 113.76, SD = 82.59)\). Following the stressor, alpha-amylase levels rose to 184.52 \((SD = 120.13)\), while the no-stress group showed a slight decline of alpha-amylase levels to 90.9
(SD = 70.89). In order to control for individual differences in alpha-amylase levels and to remain comparable to cortisol results, subsequent alpha-amylase analyses measured percent change, rather than absolute values.

4.2.3.3 Subjective and physiological measures in the stress group

4.2.3.3.1 Cortisol and anxiety

Subjective reactivity to the psychosocial stressor was calculated by subtracting pre-stressor POMS anxiety rating from the post-stressor score. The inter-quartile range (IQR) of this anxiety reactivity index was used to categorize individuals as high (n = 12), average (n = 23) or no (n=13) subjective reactivity to the psychosocial stressor. A univariate ANOVA examining anxiety reactivity index and percent change in cortisol levels between these groups following the stressor was not significant \[ F(2, 45) = .148, p = .86 \].

Percent change in cortisol levels from the first sample (upon entering the lab) to baseline, however, was related to anxiety reactivity on the POMS as shown by a univariate ANOVA \[ F(2, 45) = 3.39, p < .05 \]. A post-hoc comparison of the groups showed that individuals with high anxiety reactivity \((M = -132, SD = 173.77)\) had significantly greater changes in cortisol levels from sample 1 to sample 2 than individuals with average reactivity \((M = -47.71, SD = 64.33)\) and those with no reactivity \((M = -39.9, SD = 52.56)\). These results are depicted in Figure 15a.

Similarly, reactivity on the KUSTA anxiety subscale was calculated by subtracting the pre-stress KUSTA ratings from the post-stress rating. The IQR of the KUSTA anxiety index was used to categorize individuals as high \((n = 12)\), average \((n = 23)\) or low \((n = 12)\) anxiety reactivity. Multiple univariate ANOVAs revealed no
Figure 15. The relationship between the POMS anxiety reactivity index (low, average or high) and percent change in cortisol and alpha-amylase levels upon arrival and following the TSST. The relationship between POMS anxiety reactivity and change in cortisol levels from sample 1 to sample 2 (arrival to baseline, 4a). Individuals who reported the greatest change in anxiety following the psychosocial stressor also showed the largest drop in cortisol levels from first entering the lab to sitting and drinking for 1 hour. There was no significant difference in cortisol reactivity between the groups following the TSST (4b). The high reactivity group had significantly higher changes in alpha-amylase levels from sample 1 to sample 2 than the average and low anxiety groups (4c). Following the TSST, the high anxiety reactivity group showed greater changes in alpha-amylase levels than average and low groups 4d).

* < 0.05
significant relationships between KUSTA anxiety reactivity ratings and percent change in cortisol levels (Figures 16a and 16b).

Pearson correlation coefficients were computed for the POMS and KUSTA reactivity indices. All variables, including the Tension subscale of the KUSTA, were highly correlated (\( p < 0.001 \)). A closer examination of the Tension subscale on the KUSTA revealed a bi-modal distribution of scores in the post-stress ratings on this scale. Participants provided ratings either above or below the neutral point (i.e. they did not mark ‘neither/nor’ or ‘scarcely’ for tension), indicating that they either experienced tension or they did not. Using this neutral point of 9 as a cutoff, participants were grouped into either a high (\( n = 27 \)) or a low (\( n = 21 \)) tension group based on their post-stress KUSTA tension rating. A univariate ANOVA with tension reactivity as the between-subjects measure and percent change in cortisol levels as a within group measure, revealed a significant difference between the high and low groups in their percent change in cortisol levels from baseline to post-stressor \( [F(1, 46) = 4.33, p < .05] \). Individuals who reported low levels of tension had a mean cortisol change of 8.44% (\( SD = 59.56 \)), while those in the high tension group had a mean cortisol change of 70% (\( SD = 124.77 \)).

4.2.3.3.2. Alpha-amylase and anxiety

Using the same POMS anxiety reactivity index, a univariate ANOVA with reactivity groups as the between-subjects measure and percent change in alpha-amylase levels as the dependent measure was marginally significant \( [F(2, 41) = 3.08, p = .057] \). Post-hoc analyses revealed that individuals with a high index of anxiety reactivity had a
Figure 16. The relationship between the KUSTA anxiety reactivity index (low, average or high) and percent change in cortisol and alpha-amylase upon arrival in the laboratory (a,c) and following the TSST (b,d). There was no statistically significant difference between KUSTA anxiety reactivity and change in cortisol levels from sample 1 to sample 2 (arrival to baseline, figure 5a). Anxiety reactivity groups did not differ in cortisol reactivity following the TSST (5b). The high anxiety reactivity group showed significantly higher changes in alpha-amylase levels from sample 1 to sample 2 (5c). Following the TSST, the high anxiety group also demonstrated a greater increase in alpha-amylase levels than the average or the low groups (5d).

* < 0.05
higher percent change in AA levels ($M = 137.11$, $SD = 152.86$) than those who had average ($M = 49.59$, $SD = 78.71$) or no reactivity ($M = 55.91$, $SD = 63.55$). These latter two groups did not significantly differ from each other. These results are depicted in Figure 15d.

Percent change in AA levels from the first sample (upon entering the lab) to baseline was also related to anxiety reactivity on the POMS as shown by a univariate ANOVA [$F(2, 41) = 4.09$, $p = .02$]. A post-hoc analysis revealed that the high anxiety reactivity group ($M = 25.55$, $SD = 80.09$) had significantly higher changes in AA levels from sample 1 to 2 than the average ($M = -28.58$, $SD = 28.19$) or low ($M = -18.47$, $SD = 48.93$) POMS reactivity groups (Figure 15c).

A univariate ANOVA also showed a relationship between KUSTA anxiety reactivity and the percent change in AA levels from sample 1 to sample 2 [$F(2, 41) = 3.26$, $p > 0.05$]. A post-hoc comparison showed that the high reactivity group had significantly higher changes in AA ($M = 19.66$, $SD = 77.53$) than the average ($M = -29.47$, $SD = 35.07$) or low ($M = -8.96$, $SD = 50.76$) KUSTA anxiety reactivity groups (Figure 16c).

A univariate ANOVA, with the KUSTA anxiety index as a between-subjects measure, revealed a significant difference in the percent change in AA levels from baseline following the psychosocial stressor [$F(2, 41) = 6.93$, $p < 0.01$], in that individuals with a high anxiety index also showed the greatest change in AA levels following the stressor ($M = 162.08$, $SD = 133.88$), compared to the average ($M = 47.03$, $SD = 81.09$) and the low anxiety reactivity group ($M = 37.22$, $SD = 51.26$). These results are depicted in Figure 16d.
The KUSTA anxiety index was also related to the percent change in AA levels from post-stressor to post-task (i.e. the time following the stressor until the end of the risk-taking task) \([F(2, 41) = 7.01, p < 0.01]\). As shown in Figure 17, all three anxiety groups differed significantly in a stepwise fashion; the greatest drop in AA levels occurred in the high group \((M = -50.72, SD = 21.79)\), followed by the average group \((M = -31.76, SD = 24.93)\), with the low group demonstrating the smallest drop in AA levels \((M = -8.49, SD = 33.24)\).

A Pearson product moment correlation between the POMS and KUSTA revealed a significant positive relationship between the two measures \((p < 0.001)\).

**4.2.3.3 Subjective and physiological measures**

A 2 (POMS anxiety subscale) X 3 (experimental group) repeated-measures ANOVA was used to examine POMS mood state ratings before and after the psychosocial stressor in intoxicated and sober groups. There was a significant main effect of stress \([F(2, 45) = 60.51, p < .001]\), a marginally significant main effect of group \([F(2, 45) = 3.1, p = .055]\) as well as a group X stress interaction \([F(2, 45) = 4.42, p < .05]\). Overall, self-report anxiety ratings increased significantly following the psychosocial stressor from a pre-stress mean of -0.21 \((SD = 2.8)\) to a post-stress mean of 7.03 \((SD = 7.8)\). Following the psychosocial stressor, in a stepwise fashion, the sober group reported the highest rates of anxiety \((M = 11.85, SD = 7.8)\), followed by the placebo group \((M = 7.41, SD = 8.65)\), and then by the intoxicated group \((M = 4.43, SD = 6.35)\).
Figure 17. The relationship between anxiety reactivity on the KUSTA and alpha-amylase levels during the computer task. Individuals who reported the greatest increases in anxiety following the stressor, also showed the greatest decreases in alpha-amylase in the 25 minutes following the stressor. The average group showed significantly less decreases in alpha-amylase compared to the high group, but significantly greater changes than the low anxiety reactive group.
A 2 (KUSTA anxiety subscale rating) X 3 (experimental group) repeated-measures ANOVA revealed a main effect of stress [$F(1, 44) = 21.79, p < .001$], as well as a marginally significant main effect of group [$F(2, 44) = 2.76, p = .075$], but no significant interaction between stress and group [$F(2, 45) = 0.43, p = .66$]. Overall KUSTA anxiety ratings increased post-stress for both groups, again in a stepwise fashion; the sober group reported the highest rates [$M = 7.33, SD = 4.25$ (lower scores indicate higher anxiety levels on the KUSTA)], followed by the placebo group ($M = 9.64, SD = 3.72$), while the intoxicated group reported the lowest levels ($M = 10.56, SD = 5.22$). Only the difference between the sober and intoxicated groups was significantly different ($p < .05$).

A univariate ANOVA with experimental group as the between-subjects measure and the KUSTA tension-relaxation scale as the dependent measure revealed a significant difference between groups on this scale as well [$F(2, 45) = 4.5, p < .05$]. Post-hoc multiple comparisons showed that the sober group reported significantly lower levels of relaxation ($M = 6.08, SD = 3.52$) than either the placebo ($M = 10.27, SD = 4.41$) or the intoxicated ($M = 9.59, SD = 3.8$) groups, who did not differ from each other.

4.2.3.4. Alcohol Effects

A univariate ANOVA with experimental group as a between-subjects measure and percent change in cortisol levels as the dependent measure revealed a significant difference between groups ($F(2, 47) = 5.55, p < .01$). Specifically, the sober group displayed a significantly greater mean increase in cortisol levels in response to the psychosocial stressor ($M = 112.5, SD = 141.77$), compared to the placebo ($M = 16.2, SD$)
or the intoxicated group \((M = 10.75, SD = 75.59)\). These results are displayed in Figure 18.

A univariate ANOVA examining AA levels following the psychosocial stressor in the experimental groups did not show any significant differences between groups \([F(2, 43) = 1.06, p = .36]\).

### 4.2.3.4. Risk-taking

A 3 (experimental group) X 2 (stress) X 2 (session) repeated-measures ANOVA revealed no main effect of session \([F(1,77) = .553, p = .46]\) in that all groups showed the same mean risk-taking score on both sessions. There was no significant main effect of stress on risk-taking \([F(1, 77) = 0.36, p = .55]\), nor a significant interaction between stress and session \([F(1, 77) = 0.06, p = .81]\). Also, there was no main effect of experimental group \([F(2, 77) = 45.22, p = .91]\), nor an interaction between session, stress and intoxication. These results are depicted in Figure 19.

The following results include only individuals in the stress group. Using the KUSTA Tension subscale (described in section 3.3.3.2.) as a between-subjects measure in a repeated-measures ANOVA with mean risk-taking score as the within-subjects variable, ANOVA revealed no significant main effect of risk-taking \([F(1, 44) = 0.39, p > .05]\), but a main effect of group \([F(1, 44) = 5.33, p < .05]\). The main effect of tension group showed that, collapsed over both sessions, high-tension individuals had a higher mean risk-taking score, than low-tension individuals. There was no significant interaction between risk-taking score on the two sessions and tension group \([F(1, 44) = 0.00, p > .05]\).
Figure 18. The effect of experimental group on cortisol reactivity following the psychosocial stressor. The sober group \((n = 14)\) demonstrated a significant increase in cortisol levels following the stressor, while the placebo \((n = 12)\) and the intoxicated group \((n = 24)\) did not.
Figure 19. The effects of stress and intoxication on risk-taking. There was no difference in risk-taking scores between sessions or between groups. Note: At session 1, all groups were sober and had not yet experienced stress.
When experimental group was added as a variable in a 2 (risk-taking) by 2 (tension group) by 2 (intoxicated/sober group) repeated-measures ANOVA there was still no main effect of risk-taking \( [F(1, 42) = 0.99, p > .05] \), however, the main effect of tension became marginally significant \( [F(1, 42 = 3.98, p = .053] \). There was no main effect of treatment \( [F(1, 42) = 0.28, p = .60] \), however, there was a significant interaction between treatment and tension group \( [F(1, 42) = 4.42, p < .05] \). A pairwise comparison revealed that during session 2, the high-tension, intoxicated group showed greater risk-taking \( (M = 29.50, SE = 5.38) \) than the low-tension intoxicated group \( (M = 11.07, SE = 4.55, p < .05) \). Additionally at session 2, the sober low-tension group showed greater risk-taking than the intoxicated low-tension group \( (p = .056) \). These data are displayed in Figure 20.

4.2.3.5 Risk-taking, physiological effects of stress, and intoxication

Correlation coefficients were computed for task performance and cortisol levels throughout the experiment. There was no relationship between percent change in cortisol levels and risk-taking score on the computer task \( (p > .05) \). There was a significant positive correlation between the amount of money won on the task and percent change in cortisol levels from baseline to the stressor \( (p < .01) \) as well as the percent change from baseline to the end of the computer task \( (p < .01) \), indicating that individuals who showed the greatest change in cortisol response were those who performed best on the task.
Figure 20. An interaction between treatment and tension group on risk-taking following the psychosocial stressor. The high-tension, intoxicated group showed significantly more risk-taking than the low-tension intoxicated group.
The nature of this relationship is unclear because task performance may cause cortisol levels to rise or, conversely, high cortisol levels may enhance performance on the task. Individuals were categorized using the IQR of task performance as high (> $4.27, n = 12), average (n = 26), or low (< $-2.95, n = 12) earners. Using this categorization a univariate ANOVA revealed a significant difference in cortisol level changes between these three groups \[ F(2, 47) = 3.12, p = .05 \]. Specifically, high earners had significantly greater post-stressor increases in cortisol levels from baseline \( M = 102.93, SD = 126.96 \) than average \( M = 23.14, SD = 91.92 \) or low \( M = 15.88, SD = 84.08 \) earners. Percent change in cortisol levels at the end of the task were also related to the amount of money earned \[ F(2, 47) = 4.85, p = .01 \]. Again, high earners had significantly higher mean changes in cortisol \( M = 157.71, SD = 220.7 \) than average earners \( M = 23.95, SD = 75.25 \) and low earners \( M = 27.34, SD = 95.81 \). These data are displayed in Figure 21.

Multiple univariate ANOVAs examining the interactive effects of alcohol on this measure showed no significant effects \( p > .05 \).

An ANOVA with earning group (high, average, low) as the between-subjects measure showed a difference in the number of selections made by these groups from the risky versus the non-risky decks \[ F(2, 47) = 3.24, p < .05 \]. Specifically, the large loss group made significantly more selections from the risky deck \( M = 77.83, SD = 18.82 \) than the average \( M = 55.15, SD = 27.55 \) or high \( M = 58.75, SD = 27.92 \) earning groups, who did not differ from each other. The non-significant difference between the
Figure 21. The relationship between money earned on the risk-taking task and cortisol reactivity. The mean cortisol change from baseline following the stressor (post-stressor) was significantly greater for those individuals who earned the highest amount of money on the task ($n = 12$), than those individuals who earned average ($n = 26$) or lost large amounts ($n = 12$). There was no significant difference between groups in cortisol level increases from the time after the stressor to the end of the task. High earners continued to show increasing levels of cortisol from baseline following the risk-taking task.
later two groups is noteworthy, because it shows that the high and average earners did not differ in terms of strategy on the task.

Using the same IQR for low, average and high earners (described in section 3.4.4.2.) as the between-subjects measure, a univariate ANOVA with percent change in AA as the within-subjects measure revealed a marginally significant difference in AA level changes between these three groups post-stressor \([F(2, 43) = 3.09, p = .056]\). Post-hoc analyses showed that the percent change from baseline was largest for the high-earning group \((M = 130.79, SD = 139.91)\), compared to the average \((M = 47.11, SD = 77.06)\) and low-earning groups \((M = 54.12, SD = 82.37)\).

Examination of the percent AA change from post-stressor to post-task using a univariate ANOVA with earning group as a between-subjects variable showed a significant difference between groups \([F(2, 43) = 4.84, p < .05]\). A post-hoc analysis showed again that the high earners \((M = -51.91, SD = 16.01)\) had a significantly greater drop in AA levels than the average \((M = -19.55, SD = 32.63)\) or low \((M = -22.36, SD = 36.72)\) earners, who did not differ from each other.

There was no significant difference in AA levels between the three groups from baseline to post-task \([F(2, 43) = 0.04, p = .97]\), showing that means for all three groups were back to baseline levels. The AA data are shown in Figure 22. Multiple univariate ANOVAs examining the interactive effects of alcohol on this measure showed no significant differences \((p > .05)\).
Figure 22. Money earned and alpha-amylase reactivity. The mean alpha-amylase change from baseline following the stressor (post-stressor) was significantly greater for those individuals who earned the highest amount of money on the task. There was a significant decrease in alpha-amylase levels for the high earning group from the time after the stressor to the end of the task (during the task). There was no significant difference in alpha-amylase levels between groups following the risk-taking task (post-task).
4.3 Discussion

Overall, this study shows a close relationship between 1) subjective and physiological measures of stress, 2) expected and actual effects of alcohol and 3) cortisol and reward-sensitivity. Our results, however, do not reveal a straightforward relationship between intoxication and risk-taking, or between cortisol and AA activity.

The significant increase in Vigour, Friendliness and Elation reported by intoxicated individuals on the POMS is consistent with other studies showing a general increase in self-report measures of stimulation on the ascending limb of the Blood Alcohol Curve (Soederpalm & de Wit, 2002). In contrast, alcohol intoxication did not significantly increase hormonal or protein levels. Indeed, in the absence of stress, cortisol decreased in all groups from pre- to post-drink consumption. This is consistent with numerous reports that alcohol intoxication does not affect cortisol in non-alcoholic individuals (Waltman, Blevins, Boyd & Wand, 1993; Soederpalm & de Wit, 2002; Zimmermann, Buchmann, Steffin, Dieterle & Uhr, 2006; King, Munisamy, de Wit & Lin, 2006), although one study suggests that cortisol increases in intoxicated states (King, Houle, de Wit, Holdstock & Schuster, 2002). We also found that AA levels were not affected by acute alcohol intoxication, which contradicts a previously reported decrease in this measure (Enberg, Alho, Loimaranta & Lenander-Lumikari, 2001). The absence of a non-alcohol control group in the Enberg et al. study likely prevented these authors from observing a general decline in protein levels that may have occurred across testing. Based on our comparison with sober and placebo groups, therefore, we report that acute alcohol intoxication does not produce changes in either cortisol or AA levels.
Both subjective and physiological measures demonstrate the effectiveness of the psychosocial stressor: individuals reported significant increases in Tension, Anxiety, Depression and Anger, while reporting decreases in Mood, Friendliness, Activity and Happiness on the POMS as well as the KUSTA subscales. In parallel, these individuals manifested significant increases in the hormone cortisol and the protein AA following the stressor. We also found that stress reactivity was moderated by alcohol consumption.

Following the psychosocial stressor, the sober group reported significantly higher levels of tension on the KUSTA than either the placebo or alcohol groups, who did not differ on this measure. As in our previous studies, the protocol for administering alcohol controlled for the expectancy effect of receiving the drug. More specifically, although individuals in the placebo group did not rate themselves as intoxicated as the alcohol group, they clearly believed that they had consumed alcohol. Both the placebo and the intoxicated group showed similar profiles on the KUSTA and POMS anxiety subscales, verifying the potent effects of alcohol expectancy on subjective measures of stress. Perhaps most surprisingly, physiological measures demonstrated a similar effect: sober individuals manifested a significant increase in cortisol following the psychosocial stressor, whereas the intoxicated and placebo groups did not. This blunted cortisol response has not previously been reported since most experimental studies have only compared an intoxicated group to a placebo group (e.g. Zimmermann et al., 2006; Söderpalm & de Wit, 2002). Our results demonstrate the powerful effects of alcohol expectations; these effects appear to represent anxiolytic rather than positive reinforcing effects of alcohol, in that experimental groups differed only on subjective ratings of anxiety and tension, but not on happiness or elation following the psychosocial stressor. The potency of these effects
emphasizes that a sober control group (i.e. a group with no expectation of receiving alcohol) and placebo groups are both necessary controls to effectively evaluate the effects of alcohol on subjective and physiological responses to alcohol.

The blunted cortisol response of both intoxicated and placebo groups supports the idea that many of the stress-dampening effects of alcohol are cognitively mediated. This effect may be a conditioned response because all of the participants regularly consumed alcohol. The stress reduction effect, therefore, may be a reaction to the expectancy of receiving alcohol. If alcohol produced a direct pharmacological effect mediating the stress-dampening effect on cortisol, this would most likely have been manifested prior to the stressor. One might expect the intoxicated group to show lowered cortisol levels following drink consumption, however, there was no difference in cortisol levels between experimental groups at that time. Since cortisol also acts as a measure of central nervous system feedback (Lovallo, 2006), the lower levels of this hormone in the alcohol and placebo groups following the stressor may reflect alterations in higher cortical and limbic areas involved in arousal and affect regulation.

Our findings confirm previous reports that AA levels increase following a psychosocial stressor (Nater, Rohleder, Gaab, Berger, Jud, Kirschbaum & Ehlert, 2005) and, for the first time, reveal the combined effects of alcohol and stress on AA activity. Psychosocial stress increased AA levels in all groups, with no significant differences between them. Following the risk-taking task, AA levels returned to baseline levels, demonstrating the quick reactivity of this measure.

The association between subjective and physiological measures is further evidenced in the relationship between anxiety reactivity and AA. Individuals with high
anxiety indices on both the POMS and the KUSTA also displayed the greatest changes in AA levels following the stressor. Interestingly, cortisol reactivity was not related to the same subjective measures as AA. Following the stressor, cortisol reactivity was related only to tension responsivity on the KUSTA, confirming that cortisol and AA provide independent measures of physiological changes associated with stress. In contrast to other studies that report a lack of overlap between subjective and physiological measures of stress and anxiety (Sher et al., 2007), our study may have detected a relationship because the self-report measure we used (e.g. the POMS anxiety subscales) provides separate measures for different aspects of the stress response. This alone may have decreased demand awareness on the task. Most importantly, however, the psychosocial stressor we used (the social-evaluative component of the TSST) is very effective in eliciting a robust stress response.

Behavioural performance on the risk-taking task was not affected by acute alcohol intoxication, contradicting a previous report (Lane et al., 2004) that alcohol dose-dependently increases risk-taking on this task. The main differences between our studies may be methodological: we tested all participants in the late afternoon (between 14:00-19:00), as opposed to 9:15 am in the Lane et al. study. Our study had participants consuming each drink every 10 minutes in a group environment with at least 2 other people present, whereas Lane’s study gave alcohol to participants who sat alone in a chamber for 5 minutes. Participants in our study were paid for their performance only on the second session, and the addition of a monetary reinforcer did not affect performance on the task as mean risk-taking scores remained stable across sessions. Another difference between our studies was that we used a response option variable ratio (VR) of
4, whereby participants were required to make an average of 4 responses to complete each trial. We chose this option because it provided an average inter-trial interval of 4 seconds and maintained the interest of participants. Lane’s study used a VR – 25 schedule which perhaps provided participants with more time to reflect on their wins or losses as well as their subsequent choice.

Although we did not find a direct effect of alcohol on risk-taking, there was an interaction between tension level and risk-taking in intoxicated individuals. Individuals who reported low tension levels on the KUSTA following the psychosocial stressor also demonstrated significantly smaller cortisol increases than individuals who reported high tension levels. On both pre- and post-stressor sessions, however, low-tension individuals showed significantly less risk-taking on the task. These findings emphasize the importance of individual differences in moderating stress reactivity.

Stress-reactivity, rather than the direct effects of stress, was related to risk-taking behaviour. That is, individuals who showed the greatest cortisol change across the stress manipulation would go on to win the largest amounts of money on the risk-taking task. This finding suggests that increased cortisol levels may have made these individuals more attentive or sensitive to outcomes on the task. On the other hand, the high earning group also demonstrated an enduring rise in cortisol levels beginning from the psychosocial stressor and continuing throughout the risk-taking task; unlike the other groups, cortisol levels in high earners were elevated at the completion of the task. This persisting increase in cortisol may be explained by ‘leftover’ effects of the social stressor, but may also be due to task performance; advantageous performance may have produced the elevated cortisol levels at the end of the task. At the beginning of the risk-taking task, participants
were told they had $1.00 which they could see displayed by a counter at the top of the screen. The counter was then removed and participants did not see their cumulative earnings during the task in order that each trial could function independently. Nonetheless, individuals who were performing well most likely had a sense of their performance, having viewed the gain amount (eg. +$0.75) repeatedly over the course of 100 trials. Individuals who were average earners may not have been as certain of their performance, having seen equivalent negative and positive outcome amounts over the course of the task. Interestingly, average and high earners did not differ in their number of non-risky choices, nor in their risk-taking score. Therefore, the rise in cortisol following task performance in the high earners is most likely a function of their increasing sense of success. Advantageous performance on another decision-making task, the IGT, is also associated with increases in cortisol levels (van Honk, Schutter, Hermans & Putman, 2006). Takahashi (2004) has also demonstrated a negative correlation between cortisol levels and and time-discounting of monetary gain.

Individuals with the greatest increase in AA levels following the psychosocial stressor would also go on to earn the most money on the task. Unlike cortisol, however, AA levels decreased rapidly during the task, particularly in the high-earning group. By the end of the task, AA levels were similar in all earning groups. It is interesting that AA and cortisol, both predictive of number of stress measures, did not correlate with each other. This is consistent with other studies and supports the idea that these may index different measures of the stress response (Chatterton, Vogelsong, Lu, Ellman & Hudgens, 1996; Nater, Rohleder, Gaab, Berger, Jud, Kirschbaum & Ehlert, 2005). In our experiment, AA unambiguously reflected the acute stress response: protein levels
increased rapidly in response to stress, but promptly decreased and were unaffected by alcohol or risk-taking task performance. Cortisol levels were also altered by stress but these interacted with cognitive or ‘expectation’ effects of alcohol and task performance. Therefore, although cortisol is typically characterized as a stress hormone, unique cognitive and behavioural influences demonstrate its important role in situational appraisal. Altogether, our findings suggest that cortisol and AA gauge distinct aspects of the stress response.

As part of this study, we monitored the decline in cortisol levels from when participants entered the lab to when they had been sitting and relaxing, approximately 30 minutes later. Many studies discard the first sample, reporting the second sample as baseline because cortisol levels appear to be more ‘stable’ at this time. Here, we present evidence that the drop in cortisol from sample 1 to 2 is related to stress reactivity following the psychosocial stressor (Fig. 4). We also suspect that basal levels of cortisol are related to personal variables such as impulsivity and family history of drug use, although our current sample was not large enough and did not include the proper measures to assess this. Nonetheless, the idea that basal cortisol levels may convey important information related to stress reactivity is consistent with other research showing an increased aptitude for drug self-administration in animals with high endogenous levels of glucocorticoids (Marinelli & Piazza, 2002).

In this experiment, we provide detailed characterization of alcohol’s effect on multiple measures of stress. Although many studies report a weak relationship between subjective and physiological measures, our study revealed a relationship between subjective stress ratings on the POMS and KUSTA with both AA and cortisol changes.
Using the TSST, a paradigm that reliably increases stress, we have demonstrated that a high dose of alcohol produces a stress-dampening effect on some, but not all, measures of stress. The results of this experiment also suggest distinct effects of stress and alcohol on AA and cortisol. Given that a heightened stress reaction was related to subsequent risk-taking behaviour, stress reactivity may function as a determinant in the motivational balance between reward sensitivity and punishment avoidance. The increased cortisol levels following successful task performance suggest that activity of this hormone may be related to implicit motivational tendencies. As cortisol acts as a feedback measure to the limbic system (Lovallo, 2006), the same system engaged by stress, drugs of abuse, as well as reward-processing, any alterations in cortisol activity over time could have profound influences on motivation and subsequent decision-making. The characterization of intoxicated responding in psychologically healthy individuals is fundamental for understanding the cognitive and physiological mechanisms mediating normal behavioural adaptations to stress.
Foreword to Chapter 5

Chapter 5 consists of a manuscript submitted to *Addiction*. The author’s supervisor, M.C. Olmstead, is a co-author on this paper.
Chapter 5:

Binge drinking in an undergraduate population: the role of gender, personal drinking habits and impulsivity in the perceived effects of alcohol

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Abstract

Binge drinking on university campuses has gained attention in the past two decades, largely due to the social and health-related problems associated with drinking at this level. In order to examine the factors that may predict this behavior, we collected information on personal drinking habits from 428 undergraduate students attending a Canadian university. Students completed questionnaires examining alcohol expectations, recreational drug use and impulsivity. Mean alcohol consumption, reported by both males and females, was above binge thresholds as defined by 5 or more drinks in a row for males and 4 or more drinks in a row for females. Although rates of alcohol consumption by males was consistent with other studies, females in our sample reported higher levels than those of previous studies, suggesting that consumption in this gender may be increasing. Self-reported differences in drinking styles were related to the perceived effects of alcohol while students were intoxicated. These results suggest that individual differences in alcohol’s perceived effects may play an important role in determining the amount of alcohol consumed.

Key Words: Binge, Alcohol, College Drinking, Impulsivity, Expectations, Drug
5.0 Introduction

Alcohol consumption on college and university campuses has gained attention, not only because undergraduate students drink significantly more than adults, but also because they drink more than young adults who do not attend university (Slutske, 2005). This drinking culture is often supported by attitudes and practices shared by the social group; many consider it a rite of passage for students to engage in excessive alcohol consumption. Thus, little action has been taken to change it until recently. In one of the first comprehensive studies of college drinking, Henry Wechsler and colleagues (1994) surveyed over 17,000 US college students in 140 colleges and found widespread binge drinking with 44% of students reporting drinking at binge levels. Binge drinking is defined as “the consumption of a sufficiently large amount of alcohol to place the drinker at increased risk of experiencing alcohol-related problems and to place others at increased risk of experiencing secondhand effects”. It is typically measured as the consumption of 5 or more drinks in a row for males and 4 or more drinks in row for females (Wechsler & Nelson, 2001).

High levels of ethanol consumption within a short period of time may be particularly detrimental for college-aged students as the motivational neurocircuitry continues to develop into the early 20s (Crews, Braun, Hoplight, Switzer & Knapp, 2000; Monti, et al., 2005). Socially, alcohol-related problems associated with binge drinking range from missing a class, to driving after drinking, to engaging in unplanned and unprotected sex (Wechsler & Nelson, 2001). Binge drinking has further second-hand effects in that all students who attend schools with high rates of drinking (even those who remain abstinent), are more likely to have property damaged, their study or sleep
interrupted, the responsibility of taking care of a drunken student, or experience unwanted sexual advances (Wechsler & Nelson, 2001). Males consistently report higher rates of binge drinking, but other factors such as academic orientation and living arrangements (e.g. on or off-campus) also predict higher rates of heavy drinking (Gliksman, Adlaf, Demers & Newton-Taylor, 2003).

High rates of alcohol consumption may have long-term effects in both drinkers and non-drinkers even thought most individuals report significantly lower drinking rates in the 10 years after college (O’Neill, Para & Sher, 2001). For example, some males, particularly those with a family history of alcoholism, show consistently higher rates of drinking and alcohol-related problems over time (O’Neill et al., 2001). Some of these patterns may be established during the undergraduate years when the culture of drinking to excess is condoned and even encouraged. If we are able to identify factors that predict excessive drinking, it may be possible to curb this very damaging behavior.

The current study examined the drinking rates of undergraduate students at a Canadian university and looked at how individual factors such as impulsivity and alcohol expectations were related to drinking habits. The students at Queen’s University live on and off-campus, primarily without parents, so many are immersed in the drinking culture that characterizes college campuses. The information was gathered through questionnaires administered while students were participating in laboratory experiments examining the effects of alcohol on a variety of behaviors (Balodis, MacDonald & Olmstead, 2006; Balodis, Johnsrude & Olmstead, 2007; Balodis, Wynne-Edwards & Olmstead, 2008). As a first step, we were interested in examining personal drinking habits in comparison to other students at Canadian and American schools. We examined
gender differences in drinking rates as well as alcohol expectations. We further collected information on recreational drug use, drinking habits, expectations about alcohol effects and trait measures of impulsivity. Due to the nature of the experiments conducted in the lab, we were also able to assess how individuals with specific drinking styles (i.e. heavy, average or light) perceived the effects of an intoxicating dose of alcohol.

5.1. Methods

5.1.1 Participants

Data were collected from 428 Queen’s University students between 2002 and 2007. Participants were recruited through classes and a student volunteer subject pool. Participants were 276 male and 152 female undergraduate students ranging in age from 19-31 years, with a mean age of 20. All participants reported consuming alcohol at least once per month.

5.1.2 Measures

5.1.2.1 Self-report measures

The Barratt Impulsiveness Scale

The Barratt Impulsiveness Scale (BIS), version 11, was used as a self-report measure of individual impulsive traits. The BIS is a 30-item questionnaire with Nonplanning, Motor and Cognitive Impulsiveness subscales. Participants rate themselves on statements using a 4-point scale: rarely/never, occasionally, often or almost always. All the items on the BIS are moderately correlated with each other and the scale shows a high test-retest reliability (Patton et al., 1995; Fossati et al., 2001). Three-hundred and twenty-eight participants completed this measure.
Personal Drinking Habits (PDH)

This self-report questionnaire contains questions regarding an individual’s drinking habits, including the frequency, amount and length of drinking occasions. This questionnaire was completed by 295 participants.

Drug Use Questionnaire (DUQ)

This self-report questionnaire contains questions regarding an individual’s drug use history and that of their family. The DUQ also collects information regarding the type of drug and frequency of drug use. This questionnaire was completed by 204 participants.

Comprehensive Effects of Alcohol Questionnaire

The CEOA is a comprehensive measure of discrete alcohol expectancies, including both positive and negative factors (Fromme et al., 1993). The self-report questionnaire consists of 38 statements, first examining an individual’s expectation as to whether they are under the influence of alcohol using a 4-point Likert scale. These same 38 statements are then subjectively evaluated on a 5-point Likert scale, in which the individual rates the particular effect as good, bad or neutral. These statements have been categorized into domains of Sociability, Tension Reduction, Liquid Courage, Sexuality, Cognitive and Behavioural Impairments, Risk and Aggression and Self-Perception. The CEOA demonstrates good test-retest reliability as well as construct and criterion validity (Fromme et al., 1993). This questionnaire was completed by 121 participants.

Drug Effects Questionnaire

Participants completed a manipulation check self-report measure to examine the perceived level of intoxication and to judge the effectiveness of the placebo manipulation. This questionnaire was completed by 399 participants.
5.1.2.2 Physiological Measures

Breathalyzer

Blood alcohol concentrations were estimated through the BAL using the Intoxilyzer 400D, a handheld breath alcohol testing instrument. Participants blew air through a mouthpiece into a fuel cell which measured the alcohol concentration in the expired breath.

5.1.3. Study Procedure

All participants completed the BIS, PDH, DUQ and CEOA upon entering the lab. Participants in the intoxicated condition were weighed at the beginning of the session so that each participant would receive the same amount of alcohol. The intoxicated group received 3 alcoholic drinks consisting of a 2:1 ratio of Fresca soda to Vodka (40% alcohol), so as to raise their BAL to .08%, the legal limit in Ontario. Participants watched two episodes of ‘The Simpsons’ (totaling ~45 minutes) while consuming the drinks. The appropriate alcohol mixture was divided into 3 glasses, each consumed at 10-15 minute intervals. Following beverage consumption and task completion, participants completed the DEQ. Full description of the alcohol administration procedure is described elsewhere (Balodis, MacDonald & Olmstead, 2006; Balodis, Johnsrude & Olmstead, 2007; Balodis, Wynne-Edwards & Olmstead, 2008).

5.1.4. Statistical Analyses

Data were analysed using SPSS version 14.0 for Windows. These statistical analyses confirm a normal distribution of the data as well as homogeneity of variance. Statistical significance was set at a probability of $p < .05$. The dependent measures were analysed as follows:
The Barratt Impulsiveness Scale

Participant’s ratings on the BIS was summed according to those methods recommended by Patton and colleagues (1995). This includes a total BIS score as well as scores for the motor, nonplanning and cognitive impulsivity subscales. All correlational analyses were performed using Pearson correlations.

Drug Use Questionnaire

Answers from questions on the DUQ were dichotomously scored as yes/no for family history and recreational drug use and, based on this information, individuals were divided into positive or negative groups (i.e. positive/negative family history and recreational/no recreational drug use). One sample chi-square tests was used to examine the relationship between family history and recreational drug use. To examine the relationship between personal drinking habits and subjective effects of intoxication, positive and negative groups were used as fixed factors in ANOVAs with the personal drinking history and intoxication ratings as dependent factors.

Comprehensive Effects of Alcohol Questionnaire

Scores from the CEOA were tallied and divided into the 7 different subscales previously described as well as the positive and negative expectations recommended by Fromme and colleagues (1993). Positive factor subscales include items assessing Sociability, Tension Reduction, Liquid Courage and Sexuality. Negative factors subscales consist of Cognitive and Behavioural Impairment, Risk and Aggression, as well as Self-Perception. Scores on the CEOA were used as dependent measures in one-way ANOVAs with family history and recreational drug use from the DUQ as fixed factors.

Drug Effects Questionnaire
Subjective ratings examining perceived intoxication effects were analysed with one-way ANOVAs with the subjective rating as the dependent factor and either experimental group, drug use group, or family history as a fixed factor.

5.2 Results

5.2.1. Personal Drinking Habits

In our sample, students reported an average of 6.5 ($SD = 4.23$) drinking occasions per month with a mean of 5.99 ($SD = 2.92$) drinks consumed on each occasion. The average length of a drinking session was 4.69 ($SD = 1.31$) hours. Two one-way ANOVAs with gender as a between-subjects variable revealed that males reported significantly more drinking occasions than females [$F(1, 291) = 9.92, p < 0.01$] as well as consuming significantly more drinks on these occasions [$F(1, 291) = 31.72, p < 0.001$]. Specifically, males reported a mean of 7.27 ($SD = 4.3$) drinking occasions on which they consumed an average of 6.82 drinks, while females reported 5.77 ($SD = 3.87$) drinking occasions with a mean of 5.05 alcoholic beverages consumed at these times. These data are shown in comparison to other Canadian and American drinking rates in Figure 23. There was no significant difference in the length of the drinking occasions between genders [$F(1, 291) = 1.25, p > 0.05$].

In our sample, 68.9% of the females reported consuming 4 or more drinks, while 74.7% of males reported consuming 5 or more drinks on each drinking occasion. When questioned whether they had ever consumed more than their average amount in the past two years, 94.35% replied yes. In this case, the mean number of drinks reported was 10.75, with males reporting significantly higher rates [$F(1, 258) = 18.42, p < 0.001; M = 12.20, SD = 6.07$] than females ($M = 9.31, SD = 5.62$).
Figure 23. Average number of drinks per drinking occasion at Queen’s University in male ($n = 146$) and female ($n = 148$) undergraduate students in comparison to the Canadian Campus Survey (Gliksman, Adlaf, Demers & Newton-Taylor, 2003) and rates reported in US colleges (Slutske, 2005).
Using their respective IQR of average number of drinks, males and females were divided into drinking quantity groups: light \((n = 63)\), average \((n = 170)\), or heavy \((n = 61)\). Using these categories, 2 one-way ANOVAs showed that light drinkers reported significantly fewer drinking occasions \((M = 5.46, SD = 5.47)\) per month than heavy drinkers \((M = 7.25, SD = 3.32)\) and average drinkers \((M = 6.63, SD = 3.79)\), who did not differ from each other. All three groups differed significantly in the length of their drinking occasions in a stepwise fashion: light drinkers reported a mean of 3.83 hours \((SD = 1.35)\), average drinkers a mean of 4.74 hours \((SD = 1.17)\) and heavy drinkers a mean of 5.34 hours, \((SD = 1.16)\).

5.2.2. Drug Effects Questionnaire

Multiple one-way ANOVAs revealed that, when intoxicated, light, average, and heavy drinkers differed significantly in their ratings of feeling sober or drunk \([F(2, 144) = 7.94, p < 0.01]\), on liking the effects that they felt \([F(2, 144) = 5.12, p < 0.01]\), and on wanting more alcohol \([F(2, 144) = 9.73, p < 0.001]\). Specifically, light drinkers reported feeling significantly more drunk than the heavy and average drinking groups who did not differ from each other in their perceived level of intoxication. Heavy drinkers reported liking the intoxicating effects of alcohol significantly more than average drinkers, who themselves reported significantly greater liking scores than the light drinker group. Also, heavy drinkers reported higher ‘wanting more’ rates than average drinkers, who themselves reported wanting more than the light drinkers. When questioned, heavy drinkers also estimated lower alcohol content in the drinks than did light drinkers \((p < 0.05)\).
5.2.3. Barratt Impulsiveness Scale

The mean score on the Barratt Impulsiveness Scale (BIS) was 64.00 (SD = 9.7). A one-way ANOVA revealed no difference between genders on the BIS [F(1, 325) = 0.68, p > 0.05]. Table 4 shows the relationship between BIS scores and the PDH: overall, higher impulsivity was associated with more drinking occasions, and more drinks on these occasions.

5.2.4. Drug Use Questionnaire

On the DUQ, 38.7% of students reported having a family member with an addiction problem. Over 65% of students reported using recreational drugs, predominantly marijuana. These data are shown in Table 5. Overall, 21.6% of respondents reported using recreational drugs on a regular basis. While 34% of the sample reported no recreational drug use, 47% reported having used only one drug (marijuana), and 18% reported using multiple recreational drugs. Of those reporting multiple drug use, the mean number of drugs was 3. A one-sample chi-square test revealed that 78.5% of individuals who reported recreational drug use also reported a relative with an addiction problem [χ²(1, N = 204) = 9.36, p = 0.002].

Using recreational drug use as a between-subjects variable (multiple/one/none), 2 one-way ANOVAs revealed a significant difference between these groups on the total BIS score (F(2, 195) = 4.13, p < 0.05] as well as on the Nonplanning subscale [F(2, 195) = 4.13, p < 0.05]. In a stepwise fashion, individuals who reported no recreational drug use had significantly lower BIS scores (M = 61.78, SD = 10.07) than those who reported only one recreational drug (M = 64.36, SD = 10.72), whose score, in turn, showed a trend
Table 4. Pearson correlations between the different Barratt Impulsivity Scale (BIS) subscales and Personal Drinking Habits (PDH) and the Comprehensive Effects of Alcohol Questionnaire (CEOA).

<table>
<thead>
<tr>
<th></th>
<th>BIS Total</th>
<th>Nonplanning Subscale</th>
<th>Cognitive Subscale</th>
<th>Motor Subscale</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$N = 199$</td>
<td>$N = 199$</td>
<td>$N = 199$</td>
<td>$N = 199$</td>
</tr>
</tbody>
</table>

**PDH**

Number of drinking occasions per month

- .116
- .140*  
- .020  
- .109

Number of drinks per occasion

- .214**
- .127
- .175*  
- .215**

Length of drinking occasion

- .158*  
- .077  
- .163*  
- .118

**CEOA**

$N = 120$

Cognitive-Behavioural Impairment Expectations

- .243**  
- .196*  
- .258**  
- .134

* $p < .05$ (2-tailed)

**$p < .01$ (2-tailed)
Table 5. Descriptives of the Drug Use Questionnaire.

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes (%)</th>
<th>No (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has any family member experienced a drug and/or gambling problem?</td>
<td>38.7</td>
<td>61.3</td>
</tr>
<tr>
<td>First-degree relative</td>
<td>18.1</td>
<td></td>
</tr>
<tr>
<td>What was their drug of abuse?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alcohol</td>
<td>16.7</td>
<td></td>
</tr>
<tr>
<td>Nicotine</td>
<td>11.8</td>
<td></td>
</tr>
<tr>
<td>Cocaine</td>
<td>2.9</td>
<td></td>
</tr>
<tr>
<td>Gambling</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>Marijuana</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Have you ever used recreational drugs?</td>
<td>65.7</td>
<td>34.3</td>
</tr>
<tr>
<td>Marijuana</td>
<td>65.2</td>
<td></td>
</tr>
<tr>
<td>Mushrooms</td>
<td>11.3</td>
<td></td>
</tr>
<tr>
<td>Cocaine</td>
<td>5.9</td>
<td></td>
</tr>
<tr>
<td>LSD</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>Ecstasy</td>
<td>3.9</td>
<td></td>
</tr>
<tr>
<td>Pharmaceutical Opiates</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Salvia</td>
<td>1.0</td>
<td></td>
</tr>
</tbody>
</table>
of being lower than individuals who reported multiple drug use ($M = 67.89$, $SD = 9.29$; $p = 0.08$).

A one-way ANOVA also showed a relationship between multiple recreational drug users and personal drinking habits [$F(2, 194) = 5.18$, $p < 0.01$]. Individuals who reported multiple drug use had significantly more drinking occasions per month ($M = 8.58$, $SD = 6.32$) than just marijuana users ($M = 6.88$, $SD = 3.54$) and individuals who report no recreational drug use ($M = 5.8$, $SD = 3.58$). A one-sample chi-square test revealed that individuals who reported multiple drug use were also significantly more likely to use marijuana on a regular basis than individuals who reported only 1 drug, or no drug use [$\chi^2(2, N = 203) = 46.49$, $p < 0.001$]. Specifically, 56.8% of individuals who reported using marijuana on a regular basis were those who reported multiple drug use.

5.2.5. Comprehensive Effects of Alcohol Questionnaire (CEOA)

Multiple one-way ANOVAs examining alcohol expectations on the CEOA showed a significant difference between genders in Sociability Expectations [$F(1, 118) = 8.29$, $p < 0.01$], Tension Reduction [$F(1, 118) = 6.48$, $p < 0.05$], and Sexuality Expectations for themselves [$F(1, 118) = 7.68$, $p < 0.01$]. Specifically, females had higher sociability and sexuality expectations, while males reported greater tension reduction expectations with alcohol. In judging the general effects of alcohol, a one-way ANOVA still showed females to have greater Sociability Evaluations than males [$F(1, 117) = 4.13$, $p < 0.05$].

There was a significant positive correlation between the BIS and cognitive impairment expectations on the CEOA; individuals with high levels of cognitive impulsivity and high overall impulsivity also had higher expectations of cognitive-
behavioural impairments when intoxicated ($p < 0.01$). These results are depicted in Table 4.

5.3 Discussion

Overall, the findings of this study are similar to those from larger surveys of drinking rates at different Canadian and American colleges and universities. The mean drinking rates in this study of 6.82 drinks for males and 5.77 drinks for females is close to those reported by the Canadian Campus Survey (7.51 and 3.99 respectively) (Gliksman et al., 2003) and to the 5.9 drinks for males and 3.8 drinks for females reported in American surveys (Slutske, 2005). The slightly higher drinking rates of females in our study may simply be a result of our smaller sample. At the same time, the Canadian Campus Survey was conducted in 1998 and the Slutske study used data from 2001. It is possible, therefore, that drinking rates in females may have been increasing over the past few years. Indeed, more recent epidemiological studies suggest that the gender gap in the college drinking culture may be shrinking and that, with each new cohort, female levels of heavy drinking are becoming closer to that of males (Pederson & LaBrie, 2006).

Using the 5/4 measure of binge drinking, 67.1% of males and 58.1% of females at Queen’s University reported drinking at binge levels on a regular basis. This finding puts the usefulness of the 5/4 measure into question; in effect it categorizes more than half of the student population as binge drinkers, without differentiating between those who suffer negative consequences from their drinking and those who do not. The 5/4 measure has been criticized previously for implying that all students who drink beyond this level suffer the same level of risk (White, Kraus & Schwartzwelder, 2006). In addition to regular patterns of binge drinking (according to the above criterion), over 90% of
students also reported consuming more than their average amount of alcohol in the past two years. Indeed, both males and females reporting mean alcohol consumption, on at least one occasion, that was more than double the binge threshold. Although distinguishing patterns of undergraduate drinking is an important undertaking, it is clear that the measurements and criterion for binge drinking need to be refined. Only then can we understand this potentially damaging behavior, as well as the factors that may limit its growth.

Patterns of alcohol consumption in our study were related to differences in the perceived effects of alcohol. Although all participants received the same amount of alcohol per body weight, heavy drinkers reported feeling less intoxicated and estimated less alcohol content in their drinks than did light drinkers. Furthermore, the heavy drinking group reported greater liking of the intoxicating effects of alcohol as well as a greater desire to consume more alcohol than average and light drinkers. Interestingly, heavy and average drinkers did not differ in the number of drinking occasions per month, but were distinguished on the amount consumed on each occasion. This difference may reflect the fact that, although both groups regularly engage in drinking, an average drinker may perceive a specific level of intoxication as pleasurable, and not desire any more alcohol. It may also be that heavy drinkers have a higher tolerance for the intoxicating (e.g. disorientation) effects of alcohol, yet still experience greater pleasurable sensations. Combined with their increased desire to consume more when intoxicated, this group is particularly vulnerable to excessively high levels of alcohol intake. As one of the few studies examining the perceived effects of alcohol in intoxicated undergraduate
students, our study provides novel information on the relationship between drinking patterns and perceived drug effects.

Our data also reveal a correlation between trait impulsivity and personal drinking habits. More specifically, individuals who reported a greater number of drinks per drinking occasion had higher total BIS scores, as well as higher scores on the cognitive and motor impulsivity subscales (Table 1). These results are consistent with other studies reporting higher BIS scores in high-binge drinkers (Goudriaan, Grekin & Sher, 2007). Higher BIS scores put individuals at greater risk for impaired control, an important factor in predicting heavy episodic drinking and alcohol-related problems (Leeman, Fenton & Volpicelli, 2007). Although higher binge-drinking is related to decision-making impairments, the causal relationship between these two is not yet clear (Goudriaan et al., 2007).

In our sample, multiple drug use also correlated significantly with trait impulsivity, as measured by the BIS. This multiple recreational drug use group, which consisted of 18% of the sample, reported using a mean of 3 drugs, marijuana and two other illicit substances. These rates are consistent with those reported in other college populations (Adlaf et al., 2003; Berkowitz & Perkins, 1988; McCabe et al., 2007; Sher et al., 1991). At the same time, approximately half of all the students (47%) reported having used only marijuana and no other illicit drug. This finding may call into question the Gateway Hypothesis, that the initiation of marijuana use leads to the subsequent use of other illicit drugs (Kandel et al., 1975). Our data suggest that, rather than initial marijuana use, trait impulsivity is the important predictor of subsequent illicit drug use.
Longitudinal studies examining the initiation of drug use should assess the contribution of personality factors such as impulsivity.

There were also significant gender differences in alcohol expectations, as determined by the CEOA. In particular, females reported having greater Sociability expectations and evaluations, meaning that they consider themselves and others to be significantly more sociable with alcohol. Given that females express a preference for socializing with males, over females, when intoxicated (Young, Morales, McCabe, Boyd & D’Arcy, 2005) their Sociability outlook is likely also related to their Sexuality expectations. In the current study, females reported greater Sexuality expectations than males, a finding that may be congruent with the increased drinking rates reported in females. Women who drink at higher rates may be shunning the traditional gender roles in drinking patterns, not in an attempt to achieve the same social position as males, but rather because women perceive this behaviour to be more sexually appealing to males (Young et al., 2005). Using qualitative data, Young and colleagues (2005) suggested that the ability of college women to “drink like a guy” was based on an expression of the women’s sexuality. Women in her study emphasized that they did not want a social position exchangeable with males, but rather expressed that matching drinking rates was more appealing to males and granted them an elevated social position relative to other women.

The results of the current study are restricted by the small sample size and the limitations associated with self-report measures. Our data are derived from undergraduate students who report consuming alcohol at least once per month. Based on this criterion, approximately 15% of students were not eligible for participation in the studies.
Nonetheless, our drinking and drug use rates are consistent with those reported in larger Canadian and American studies. Indeed, the similarity across studies in the prevalence of heavy drinking among 19 and 20 year-olds in American college samples provides further evidence that actual age, rather than legal drinking age, is the important determinant of alcohol consumption (Kuo, Adlaf, Lee, Gliksman, Demers & Wechsler, 2002). Additionally, the increased female drinking rates in our study provide some evidence that Canadian undergraduate drinking trends are moving in parallel with American patterns. This increase is particularly alarming as females, due to metabolic differences, have greater proportions of alcohol entering the bloodstream than males who drink the same amount (Frezza et al., 1990). The gender differences in alcohol expectations may play a further role in changing drinking patterns and may reflect the influence of alcohol marketing campaigns which promote a sexual and liberating image associated with alcohol consumption.

In discussing alcohol use on college campuses, Wechsler and Nelson (2006) advocate preventative measures that focus on the majority of students who exhibit less excessive drinking, rather than the small group with extremely high levels of alcohol consumption. This may not be practical or appropriate in that our data show that the majority of students’ average drinking rate is greater than binge threshold levels. Thus, the usefulness of the 5/4 measure is questionable and may not effectively differentiate those at risk for alcohol-related problems. Future studies should examine individual variables, such as impulsivity and alcohol expectations, more carefully to establish whether these are important factors in determining drinking patterns and drug use. In
particular, prevention strategies may need to be more direct in challenging alcohol expectations and may need to be specifically tailored for each gender.
Chapter 6: General Discussion

6.0 Summary

At least some aspects of affective processing may be revealed by studying the behaviour and decision making of an individual. Affect includes both mood and emotion and represents the impact of an object or a situation on a person (Duncan & Barrett, 2007). Core affect has eloquently been described as “a neurophysiologic barometer of the individual’s relationship to an environment at a given point in time” (Duncan & Barrett, 2007). Affective stimuli, either appetitive or aversive, activate the motivational system which subsequently organizes a response. Alcohol is commonly used to alter affective states, although the mechanism by which this occurs is not understood. The present series of investigations examined the role of acute alcohol intoxication in affective processes using a variety of tasks. These studies incorporated subjective reports, physiological changes as well as behavioural measures as indices of emotional arousal. Alcohol intoxication did not directly alter decision-making, preference formation or risk-taking. In Chapter 2, we showed that acute intoxication does not impair decision-making on the IGT. When participants received the proper instructions and had full knowledge of the experimental purpose, sober and intoxicated participants showed similar affective processing in their sensitivity to rewards and punishments, and were able to shift their playing strategy away from the initial high-paying decks, developing a clear preference for the advantageous decks. The unimpaired performance in this age group of 19-25 year-olds indicates some functional maturity of the OFC, since younger teenagers do not yet show normal performance on this task (Hooper et al., 2004). Given the large variability in performance in the intoxicated group, we concluded that, rather than alcohol directly
impairing performance, individual differences in affective responses to alcohol have a significant impact on decision-making process.

In Chapter 3, we found an unexpected effect of individual variables on preference formation. Individuals who reported recreational drug use or a family history of addiction demonstrated a blunted conditioning to cues predictive of reward. This demonstrates that individuals who are already at an increased risk for addiction were less perceptive in associating particular environmental stimuli with affective preferences. A corollary of this finding is that these individuals may require greater incentives in order to develop an affective response. On the CPP, we also demonstrated a very clear dissociation between implicit and explicit learning: intoxication did not alter the ability to develop an unconscious affective response, but alcohol impaired both declarative knowledge and working memory.

In Chapter 4 we expanded our analysis of affective processing by examining stress as an example of aversive affect. We demonstrated a clear relationship between subjective and physiological measures of stress, while showing dissociable effects on cortisol and AA. By using a sober group in addition to a placebo group, we were able to show the potent effects of alcohol expectancy: both alcohol and the expectation of receiving alcohol blunted the subjective and physiological reactions to stress. Acute alcohol intoxication did not affect performance on the risk-taking task but, once more, we found that an individual variable, in this case tension-reactivity, moderated risk-taking performance. This experiment also showed a relationship between stress-reactivity and subsequent risk-taking performance. One explanation of these findings is that higher levels of cortisol increased individual sensitivity to task outcomes.
Finally, in Chapter 5, by examining all of the demographic and individual variables collected over the course of these experiments, we were able to provide a current assessment of drinking patterns at Queen’s University. Although many epidemiological studies report general drinking rates, few studies have looked at the perception of alcohol’s effects in intoxicated undergraduates. In so doing, we uncovered differences in alcohol sensitivity: heavy drinkers show a greater sensitivity to the pleasurable effects of alcohol, while concurrently feeling less intoxicated and desiring more alcohol. These significant differences in affective reactions to the intoxicating effects of alcohol may put the heavy drinkers at risk for greater alcohol-related problems. We also found a trend that females reported consuming more alcohol than reported in previous studies. Even if female consumption rates are approaching that of their male counterparts, there remain significant gender differences in alcohol expectations. Overall, the drinking patterns reported by undergraduates were consistent with those reported by larger studies and were significantly higher than binge threshold levels.

Taken as a whole, these studies suggest that individual factors, rather than a direct pharmacological effect of alcohol, play an important role in moderating affective processing.

6.1 Alcohol and Decision-Making

Although acute alcohol intoxication does not impair decision-making on the IGT, a relationship between drinking and maladaptive decision-making is noted frequently. Goudriaan, Grekin & Sher (2007), in a longitudinal study, showed that chronic, high binge-drinkers demonstrate disadvantageous performance relative to low-binge drinkers. Furthermore, earlier binge drinking was associated with poor decision-making, although
the experimental design could not determine whether the impaired decision-making was a cause or effect of the alcohol use. Consistent with our findings, Goudriaan and colleagues found higher impulsivity scores were related to higher binge drinkers, and also reported no direct relationship between impulsivity and IGT performance. Bechara (2002) has emphasized differences between decision-making and impulsivity, noting that these two processes can be differentiated both anatomically and cognitively. Whereas impulsivity requires that an individual inhibit a pre-potent response, decision-making requires the appraisal of multiple competing options, outcomes and strategies, with no clear correct choice. Our findings support the idea that these processes are at least partly independent, since neither IGT, CPP or risk-taking performance was directly related to trait measures of impulsivity. Alternatively, the self-report BIS may not accurately correspond to behavioural measures on the task we used. Responses on the BIS may represent an individual’s self-attributed motives, rather than their implicit or automatic temperament (Wilson, 2002). That is, the BIS may be consistent with the student’s view of themselves as a fun-loving, easy-going young adult, but not necessarily with their cognitive strategies in monitoring reward.

6.2 Alcohol and Individual Differences in Arousal

These collected studies also demonstrate the importance of arousal in affective processing. The incentive value of environmental stimuli, either appetitive or aversive, is rooted in its ability to activate emotional responses. Deficits in the ability to perceive or ignore stimuli may alter the emotional response and, in so doing, alter judgment and behaviour.
In Chapter 3, large individual differences in the ability of patterns to elicit affective learning on the CPP demonstrate considerable variation in the preparedness of ‘learning to like’. In a subset of individuals, task stimuli on the CPP were not sufficiently arousing to elicit an affective response. Therefore, the generation of emotions can be viewed as a product of the appraisal process. Individuals who fail to notice reinforcers, or experience natural reinforcers as less rewarding, may be more likely to seek out greater sensations, often in the form of drugs or risky behaviours.

Conversely, an individual whose arousal system is overactive, may seek a means to diminish their stress. Indeed, the anxiolytic properties are cited as one of the main motivators for alcohol use (Boys, Marsden & Strang, 2001). In Chapter 4 we found that an interaction of alcohol with tension reactivity, not alcohol intoxication alone, was related to subsequent risk-taking. This chapter further demonstrated how the arousal value of a stimulus was related to subsequent risk-taking task performance. Individuals who showed the greatest physiological reaction to the stressor (as measured through cortisol and AA levels), demonstrated the best performance on the risk-taking task. This emphasizes that not only the generation of emotions, but also the intensity of emotions produced through the appraisal process may have increased sensitivity to environmental contexts. Indeed, sensitivity of the arousal system was also demonstrated in the same experiment without using a stressor; the initial decline in cortisol levels from sample 1 to sample 2 was related to several measures of later stress reactivity. Therefore, individual cortisol reactivity from arrival until resting may provide information on the endogenous arousal sensitivity of the individual. This is an interesting and important finding, as most
studies pay no attention to initial cortisol levels. Future studies should examine further the predictive validity of this responsivity with other measures of arousal.

Cortisol is often viewed as a physiological measure of stress, however, our research indicates a much more intricate function for this hormone. It is noteworthy that when participants sat in the lab and completed crossword puzzles (i.e. when arousal was low) in the no-stress control condition, cortisol levels did not differ between the sober and intoxicated groups and effectively declined over time in both groups. Even though cortisol levels increased in individuals who experienced the psychosocial stressor, stress itself can be considered the extreme pathological continuum of the body’s normal arousal system (Koob & Le Moal, 2001). The appraisal value of a stressor can generate both physiological and behavioural modifications (Lazarus & Folkman, 1984) as we demonstrated that arousal levels following the stressor was related to future risk-taking performance. The continued cortisol increase following successful performance supports an evaluative role for this hormone in guiding behaviour.

The appraisal process may be implicit as well; the subjective and physiological stress-dampening effect manifested in the placebo group provides evidence that this effect may be an automatic, conditioned response. This suppression is of great significance, as cortisol has profound influences on affective and behavioural regulation. Although the placebo and alcohol groups did not display altered risk-taking on the task, chronic disturbances in cortisol release may, over time, disrupt affective processing.

6.3 Mechanisms of Affective Processes

Until recently, the study of emotion was considered unscientific. However, the recent use of cognitive paradigms in the study of affective processes has begun to shed
light on the systems underlying these processes. Although cognitive and affective functions have been viewed traditionally as qualitatively different, there appears to be substantial overlap between these two types of processes. In the brain, the affect-cognition distinction is not represented in neurocircuitry; indeed, the numerous reciprocal connections between the traditionally ‘affective’ brain regions (i.e. amygdala and ventral striatum) and ‘cognitive’ brain regions (i.e. OFC and anterior cingulate) make it virtually impossible to delineate boundaries between the two (Duncan & Barrett, 2007). These circuits combine sensory information external to the body with sensory information within the body, supporting the idea of affect as a form of cognition (Duncan & Barrett, 2007).

Both acute stressors and most drugs of abuse alter the functional strength of mesolimbic dopaminergic excitatory synapses, thereby providing evidence that these midbrain cells signal the motivational significance of a stimulus (Saal, Dong, Bonci & Malenka, 2003). Dopamine activity here is further modulated by prefrontal mechanisms, particularly the OFC, which mediates the magnitude of neurotransmitter release, and in this manner influences the value of rewards (Volkow, Wang, Telang, et al., 2007). The orbitofrontal-striatal circuit itself is susceptible to glucocorticoid activation, as evidenced by the large number of hormone receptors in this area (Seckl, Dickson, Yates & Fink, 1991; Sanchez, Young, Plotsky & Insel, 2000). An increasing number of studies, therefore, are beginning to view glucocorticoid dysfunction as a major contributor to disorders of mood and motivation (Erickson, Drevets & Schulkin, 2003).

The development of these neural systems occurs during adolescence, when the brain undergoes dramatic physiological changes. In particular, the maturation of limbic
and prefrontal cortical areas occurs during adolescence and even young adulthood,
with significant pruning and reorganization of the dopaminergic system (for a review see
Spears, 2000). It is still unclear what effect heavy drinking might have on the maturing
motivational neurocircuitry. Dopaminergic alterations, through excessive drug use, may
alter the neuromaturational process and the motivational substrates, thereby promoting
increased sensation-seeking and changing incentive motivational processes (Chambers,
Taylor & Potenza, 2003). It is therefore critical that research focus on this developmental
timeframe, when individuals have the greatest biological vulnerability and are
concurrently most likely to consume drugs in high quantities (Chambers et al., 2003).

6.4 Conclusion

There are many commonly-held beliefs about alcohol’s effects on physiology and
behaviour. it is unrealistic, however, to assume that alcohol would homogeneously alter
complex behaviours in all individuals. While it is commonly believed that decisions are a
consequence of the information from the object of judgment, an individual’s evaluations
further reveal information about their own personal affective reactions (Clore &
Huntsinger, 2007). The data presented in this thesis suggest that specific individual
differences in affective processing influence decision-making, preference formation and
risk-taking. Although alcohol did not directly alter complex behaviours, individual
variables, such as stress reactivity, may moderate alcohol’s effect on these. Alcohol may
enhance or inhibit appraisal mechanisms, and thereby further shape emotional responses
and subsequent behaviour. These studies assessed acute alcohol intoxication in healthy
individuals to characterize affective processes that may shed some light on the etiology
and development of addiction vulnerability. Further research should use a longitudinal
design in order to examine changes in subjective, physiological and behavioural measures following chronic alcohol use during the critical developmental period of adolescence and early adulthood.
References


Appendix I - Pre-screening Questionnaire

Pre-screening Questionnaire

Have you consumed alcohol in the past month? □ yes □ no

Have you ever had any allergic reactions to alcohol? □ yes □ no

Are you currently on any medication that may interact with alcohol? □ yes □ no

Do you have a current or prior cardiovascular condition? □ yes □ no

Have you ever had a serious head injury or stroke? □ yes □ no

Do you suffer from seizures or migraines? □ yes □ no

Please fill out the following information:

Name:__________________________________________________

Date of Birth:____________________________________________

Phone number:____________________________________________

Email:___________________________________________________
### Appendix II – The Barratt Impulsiveness Scale

<table>
<thead>
<tr>
<th>BIS-11</th>
<th>Participant #</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Directions:</strong> People differ in the ways they act and think in different situations. This is a test to measure some of the ways in which you act and think. Read each statement carefully and <strong>DARKEN THE APPROPRIATE CIRCLE</strong> to the right of the statement. Answer quickly and honestly.</td>
<td>Rarely/Never</td>
</tr>
<tr>
<td>1. I plan tasks carefully</td>
<td></td>
</tr>
<tr>
<td>2. I do things without thinking</td>
<td></td>
</tr>
<tr>
<td>3. I make up my mind quickly</td>
<td></td>
</tr>
<tr>
<td>4. I am happy-go-lucky</td>
<td></td>
</tr>
<tr>
<td>5. I don’t “pay attention”</td>
<td></td>
</tr>
<tr>
<td>6. I have “racing” thoughts</td>
<td></td>
</tr>
<tr>
<td>7. I plan trips well ahead of time</td>
<td></td>
</tr>
<tr>
<td>8. I am self-controlled</td>
<td></td>
</tr>
<tr>
<td>9. I concentrate easily</td>
<td></td>
</tr>
<tr>
<td>10. I save regularly</td>
<td></td>
</tr>
<tr>
<td>11. I “squirm” at plays or lectures</td>
<td></td>
</tr>
<tr>
<td>12. I am a careful thinker</td>
<td></td>
</tr>
<tr>
<td>13. I plan for job security</td>
<td></td>
</tr>
<tr>
<td>14. I say things without thinking</td>
<td></td>
</tr>
<tr>
<td>15. I like to think about complex problems</td>
<td></td>
</tr>
<tr>
<td>16. I change jobs</td>
<td></td>
</tr>
<tr>
<td>17. I act “on impulse”</td>
<td></td>
</tr>
<tr>
<td>18. I get easily bored when solving thought problems</td>
<td></td>
</tr>
<tr>
<td>19. I act on the spur of the moment</td>
<td></td>
</tr>
<tr>
<td>20. I am a steady thinker</td>
<td></td>
</tr>
<tr>
<td>21. I change where I live</td>
<td></td>
</tr>
<tr>
<td>22. I buy things on impulse</td>
<td></td>
</tr>
<tr>
<td>23. I can only think about one problem at a time</td>
<td></td>
</tr>
<tr>
<td>24. I change hobbies</td>
<td></td>
</tr>
<tr>
<td>25. I spend or charge more than I earn</td>
<td></td>
</tr>
<tr>
<td>26. I have outside thoughts when thinking</td>
<td></td>
</tr>
<tr>
<td>27. I am more interested in the present than the future</td>
<td></td>
</tr>
<tr>
<td>28. I am restless at lectures or talks</td>
<td></td>
</tr>
<tr>
<td>29. I like puzzles</td>
<td></td>
</tr>
<tr>
<td>30. I plan for the future</td>
<td></td>
</tr>
</tbody>
</table>

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Appendix III – Personal Drinking Habits

Personal Drinking Habits

Participant # _____________________

1. On average, how many times per month do you drink?

2. On these occasions, how many drinks do you usually consume?

Note: 1 Drink = 1.5 oz of rum, rye, scotch, brandy, gin, vodka etc., 1 12 oz bottle of beer, 5 oz of wine, or 3 oz of fortified wine.

3. Over the last 2 years, were there special occasions when you drank more or less than this average amount?

If so, indicate the amount consumed over a specified time period (e.g., 5 drinks/night on 2 occasions).

4. How long do your drinking occasions generally last (e.g., 1 hour, 4 hours, 12 hours, etc.)?
Appendix IV – Drug Use Questionnaire

**Drug Use Questionnaire**

1. Has any family member ever experienced a drug and/or gambling problem?

   If so, what is your relationship to the individual?

   What is their primary drug of abuse (e.g., alcohol, nicotine, etc. or gambling)?

2. Have you ever used recreational drugs, other than alcohol?

   If so, what drug(s)?

3. Do you use recreational drugs on a regular basis?

   If so, what drug(s)?

4. How often do you use each drug (e.g., daily, weekly, monthly)?

5. Please indicate which of the following types of gambling you have done in your lifetime.

   - Not at all
   - Less than once a week
   - Once a week
   - Once a week or more

   - □ □ □ Play cards for money
   - □ □ □ Bet on horses, dogs or other animals
   - □ □ □ Bet on sports
Played dice games
Gambled in a casino (legal or otherwise)
Played the numbers or bet the lotteries
Played bingo for money
Played the stock, options and/or commodities
Played slot machines, poker machines or other
Pull tabs or “paper” games other than lotteries

6. What is the largest amount of money you have ever gambled with on any one-day?
   □ Never have gambled
   □ $1 or less
   □ more than $1 up to $10
   □ more than $10 up to $100
   □ more than $100 up to $1000
   □ more than $1000 up to $10,000
   □ more than $10,000

7. When you gamble, how often do you go back another day to win back the money you lost?
   □ Never
   □ Some of the time (less than half of the time I lost)
Most of the time I lost
Everytime I lost

8. Have you ever claimed to be winning money gambling but were not really? In fact, you lost?

9. Did you ever gamble more than you intended to?
   - No
   - Yes

10. Do you feel you have ever had a problem with betting money or gambling?
   - No
   - Yes
   - Yes, in the past but not now

11. We may be interested in following up this study in the future. If so, could we contact you in 2-3 years through the Queen's student directory?
   - No
   - Yes

Note: your responses on these questionnaires and data computer tasks remain confidential. That is, we do not contact participants based on their performance in today's session.
Appendix V – Comprehensive Effects of Alcohol Questionnaire

Comprehensive Effects of Alcohol: Expected Effects

This questionnaire assesses what you would expect to happen if you were under the influence of alcohol. Mark a response from (1) for disagree to (4) for agree, depending on whether or not you would expect the effect to happen to you if you were under the influence of alcohol. These effects will vary, depending upon the amount of alcohol you typically consume.

This is not a personality assessment. We want to know what you would expect to happen if you were to drink alcohol, not how you are when you are sober. Example: If you are always emotional, you would not mark agree as your answer for the statement “I would be emotional” unless you expected to become MORE EMOTIONAL if you drink.

<table>
<thead>
<tr>
<th>If I were under the influence of alcohol:</th>
<th>Disagree</th>
<th>Slightly Disagree</th>
<th>Slightly Agree</th>
<th>Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I would be outgoing</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2. My senses would be dulled</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>3. I would be humorous</td>
<td>1</td>
<td>2</td>
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<td>4</td>
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<tr>
<td>4. My problems would seem worse</td>
<td>1</td>
<td>2</td>
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<tr>
<td>5. It would be easier to express my feelings</td>
<td>1</td>
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<td>6. My writing would be impaired</td>
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<td>7. I would feel sexy</td>
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<tr>
<td>8. I would have difficulty thinking</td>
<td>1</td>
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<tr>
<td>9. I would neglect my obligations</td>
<td>1</td>
<td>2</td>
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<tr>
<td>10. I would be dominant</td>
<td>1</td>
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<tr>
<td>11. My head would feel fuzzy</td>
<td>1</td>
<td>2</td>
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<tr>
<td>12. I would enjoy sex more</td>
<td>1</td>
<td>2</td>
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<td>4</td>
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<tr>
<td>13. I would feel dizzy</td>
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<td>14. I would be friendly</td>
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<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>15. I would be clumsy</td>
<td>1</td>
<td>2</td>
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<td>4</td>
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<tr>
<td>16. It would be easier to act out my fantasies</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>17. I would be loud, boisterous, or noisy</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>18. I would feel peaceful</td>
<td>1</td>
<td>2</td>
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<tr>
<td>19. I would be brave and daring</td>
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<tr>
<td>20. I would feel unafraid</td>
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<tr>
<td>21. I would feel creative</td>
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<tr>
<td>22. I would be courageous</td>
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<tr>
<td>23. I would feel shaky or jittery the next day</td>
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<td>24. I would feel energetic</td>
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<tr>
<td>25. I would act aggressively</td>
<td>1</td>
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<td>26. My responses would be slow</td>
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<td>27. My body would be relaxed</td>
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<td>28. I would feel guilty</td>
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<td>29. I would feel calm</td>
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<td>30. I would feel moody</td>
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<tr>
<td>31. It would be easier to talk to people</td>
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<td>32. I would be a better lover</td>
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<td>33. I would feel self-critical</td>
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<td>34. I would be talkative</td>
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<td>35. I would act tough</td>
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<td>36. I would take risks</td>
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<td>37. I would feel powerful</td>
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<td>38. I would act sociable</td>
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</tbody>
</table>
Comprehensive Effects of Alcohol: Evaluations

This questionnaire assesses whether you think each effect, which may result from drinking alcohol, is bad or good.

Mark a response number from 1, for bad, to 5, for good – depending on whether you think this particular effect is bad, neutral or good, etc.

We want to know if you think a particular effect is bad or good, REGARDLESS of whether you expect it to happen to YOU personally when you drink alcohol.

<table>
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<th>Slightly Bad</th>
<th>Neutral</th>
<th>Good</th>
<th>Good</th>
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<td>2. Dulled senses</td>
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<td>3. Being humorous</td>
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<td>4. Problems seeming worse</td>
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<td>5. Expressing feelings more easily</td>
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<td>6. Impaired writing</td>
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<td>7. Feeling sexy</td>
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<td>5</td>
</tr>
<tr>
<td>26. Having slow responses</td>
<td>1</td>
<td>2</td>
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<td>4</td>
<td>5</td>
</tr>
<tr>
<td>27. Having a relaxed body</td>
<td>1</td>
<td>2</td>
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</tr>
<tr>
<td>28. Feeling guilty</td>
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<tr>
<td>29. Feeling calm</td>
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<tr>
<td>30. Feeling moody</td>
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<tr>
<td>31. Being easier to talk to people</td>
<td>1</td>
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</tr>
<tr>
<td>32. Being a better lover</td>
<td>1</td>
<td>2</td>
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<tr>
<td>33. Feeling self-critical</td>
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<tr>
<td>34. Being talkative</td>
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<tr>
<td>35. Acting tough</td>
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<tr>
<td>36. Taking risks</td>
<td>1</td>
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<td>5</td>
</tr>
<tr>
<td>37. Feeling powerful</td>
<td>1</td>
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<td>4</td>
<td>5</td>
</tr>
<tr>
<td>38. Acting sociable</td>
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</tr>
</tbody>
</table>
Appendix VI – Drug Effects Questionnaire

**Drug Effects Questionnaire**

Participant # ______________________

Please rate your feelings on the following scales by circling the number that approximates your current state.

1. I feel…

1 2 3 4 5 6 7 8 9

sober drunk

2. I like/dislike the effects I feel:

1 2 3 4 5 6 7 8 9

dislike like

3. I do/do not want more to drink:

1 2 3 4 5 6 7 8 9

do not want
want more more
Appendix VII – Manipulation Check

Manipulation Check

Participant # ______________________

Now, we are interested in knowing how accurately you can estimate your present level of intoxication. Please complete the questions below.

1. How intoxicated do you feel right now?

   1 2 3 4 5 6 7 8 9

   not at all  mildly  moderately  very  extremely
   intoxicated  intoxicated  intoxicated  intoxicated

2. Estimate, in bottles of beer, how much alcohol you have consumed.

   1 2 3 4 5 6 7 8 9

   no beer  less than 1 bottle 2 bottles 3 bottles 4 bottles 5 bottles 6 bottles more than
   1 bottle of beer of beer of beer of beer of beer of beer 6 bottles

3. Recall that pure alcohol is 40% alcohol. Think of the mixed drinks that you received, what do you think the alcohol content was?

   0% 5% 10% 15% 20% 25% 30% 35% 40% (pure alcohol)

4. The legal blood alcohol limit in Ontario is 0.08%.

   If you were to estimate your blood alcohol level right now, what do you think it would be?

   ____________%

5. Write down the first response that comes to mind to complete this sentence:

   “Alcohol makes one….”
Appendix VIII – Declarative Knowledge Questionnaire

**Declarative Knowledge**

Did you see any of these patterns while you were searching for the red ball and counting? Which ones?

Do you remember seeing any of these with the red ball a lot? Which ones?

Do you remember seeing any of these with the black ball a lot? Which one or ones?

Three of these patterns were shown during the red ball test. Can you guess which 3?

How sure are you of your choices?

<table>
<thead>
<tr>
<th>Certain</th>
<th>Quite sure</th>
<th>Not very sure</th>
<th>Guess</th>
</tr>
</thead>
</table>

Appendix IX – Profile of Mood States

Study No  Subject No.  Day
Time

Please rate from 0= not at all to 4=extremely, how the different adjectives represent your current mood state

<table>
<thead>
<tr>
<th>Not at all</th>
<th>A little</th>
<th>Moderately</th>
<th>Quite a bit</th>
<th>Extremely</th>
<th>Not at all</th>
<th>A little</th>
<th>Moderately</th>
<th>Quite a bit</th>
<th>Extremely</th>
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<td>0 1 2 3 4 4 Friendly</td>
<td>0 1 2 3 4 Lonely</td>
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<tr>
<td>0 1 2 3 4 Tense</td>
<td>0 1 2 3 4 Miserable</td>
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<td>0 1 2 3 4 Happy</td>
<td>0 1 2 3 4 Efficient</td>
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<td>0 1 2 3 4 Angry</td>
<td>0 1 2 3 4 Bitter</td>
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<tr>
<td>0 1 2 3 4 Worn out</td>
<td>0 1 2 3 4 Pleased</td>
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<td>0 1 2 3 4 Unhappy</td>
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<td>0 1 2 3 4 Ready to fight</td>
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<tr>
<td>0 1 2 3 4 Unable to concentrate</td>
<td>0 1 2 3 4 Good-natured</td>
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<tr>
<td>0 1 2 3 4 Sorry for things done</td>
<td>0 1 2 3 4 Gloomy</td>
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<tr>
<td>0 1 2 3 4 Shaky</td>
<td>0 1 2 3 4 Desperate</td>
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Please complete this form stating how you feel right now. Make a broad mark in one box from each of the six columns.

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<td>Happy, cheerful, in good spirits</td>
<td>Fresh, alert, active, feeling desire to work</td>
<td>Calm, easeful, well-balanced, even-tempered</td>
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Extremely strong

Not at all
Appendix XI – Trier Social Stress Test Administration Protocol

TSST Administration Protocol

1. Tell participant: “We are going to ask you to do a task to verify your alertness before doing the computer task.”

2. Bring participant into Cella’s office where 3 persons are already sitting at a table and a video camera is set up.

3. Introduce them: “This is Dr. _____ who just completed their degree in behavioural neuroscience. ________ is a doctoral student in linguistics and this is __________ who is specifically trained to monitor nonverbal behaviour.

   The video recorder will allow us later to do a voice frequency analysis and examine your nonverbal behaviour. We would like you to give a pretend talk for a job interview. Pretend that you were interviewing for a job to work here in the Psychology department. You can talk about your academic history and any relevant work or volunteer experience that might make you a good candidate for the job. You can have 10 minutes to prepare the talk. There is a paper and pen that you can use to develop an outline for the talk.”

4. When participant is finished with outline, take it from them and place on clipboard.

5. ‘Manager A’ can now welcome the job applicant: “Thanks for coming in ________. In the next 5 minutes, please tell us why you would be a good candidate as a research assistant in the psychology department.”

6. ‘Manager B’ can monitor time on the stopwatch.
7. If the participant finishes in less than 5 minutes: “You still have some time left. Please continue!”

8. If the participant finishes a second time before the 5 minutes is up wait 20 seconds and then ask prepared questions:

   Eg.
   a. “Do you have any other experience that might be relevant?”

   b. “What courses in your undergraduate program do you think are most relevant for a position as a research volunteer?”

   c. “Are you planning to go on to graduate school?”

9. At time +15 begin math component. “We are going to ask you just a few simple math questions to further verify your alertness. Don’t worry, these questions are very simple and most people don’t have any problem with them. Can please serially subtract the number 17 from 1033 as fat and as accurately as possible.”

10. After several numbers say: “Please try and subtract a little bit faster.”

11. If you notice one wrong: “That was incorrect, please begin now at 1223 and serially subtract by 13.”

12. After several numbers say: “Please try and keep eye contact with us.”

13. After a while when an incorrect one comes up: “That was incorrect, please begin now at 7475 and subtract 19.”

14. “Please try a bit faster.”

15. “Thank you, that’s enough.”

16. Take another cortisol sample.