An Investigation into the Opposing Inclinations of Alcohol Craving,
Risky Decision-Making and Alcohol Consumption Behaviour

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Abstract
Growing evidence suggests that alcohol craving manifests as a combination of approach and avoidance of alcohol simultaneously, which challenges the traditional conceptualization of craving as experienced from weak to strong on a single dimension. The strength of these competing inclinations is argued to be dependent on the degree of neurobiological changes that occur with repeated alcohol use. These neurobiological changes may exacerbate craving, which then increases the risk of continued maladaptive alcohol use. Importantly, decision-making ability has also found to be impaired as a result of alcohol use and likely further facilitates uncontrolled drinking behaviour.

Since alcohol craving and decision-making are linked to similar neural substrates, it was anticipated that induced alcohol craving would result in impaired decision-making performance by drinkers on laboratory-based risk tasks. The relationship between craving and decision-making has important implications for understanding the development of and recovery from alcohol addiction.

This thesis consisted of three study phases that addressed the following aims. Firstly, to validate the two-dimensional (approach, avoidance) conceptualization of alcohol craving during an alcohol cue exposure paradigm. Secondly, to determine if there would be performance differences between high and low drinkers or those exposed to alcohol versus non-alcohol cues on traditional and newly modified behavioural decision-making tasks. Furthermore, to examine whether there is an association between approach and avoidance inclinations and risk taking on these tasks. Thirdly, a self-report alcohol-related risk measure was developed to explore which types of risk behaviour are most strongly implicated during alcohol use.
Over a series of studies, young Australian adults were exposed to alcohol cues and then completed the Iowa Gambling Task, the Balloon Analogue Risk Task (BART), and a modified version of the BART that presented alcohol-specific stimuli, namely the DART (Drinking Analogue Risk Task). Results showed that approach inclinations significantly increased for both high and low risk drinkers following alcohol cue exposure. However, only in high risk drinkers did avoidance significantly decrease following alcohol cue exposure. This suggested that high risk drinkers are vulnerable to rapid and imbalanced inclinational changes in craving, increasing the potential for losses of control. By contrast, low risk drinkers were characterised by a more resilient response to alcohol cue exposure, likely protecting them against potential losses of control. Importantly, a relative balance score, calculated by subtracting avoidance from approach, showed that, at baseline, both high and low risk drinkers exhibited larger avoidance than approach inclinations. However, exposure to alcohol cues shifted high risk drinkers toward a dominant approach profile while low risk drinkers maintained a dominant avoidance profile.

While no decision-making performance differences were found between the groups or exposure conditions on the behavioural tasks, the BART and the DART were associated with both craving inclinations. Specifically, approach was positively associated with risk taking in high risk drinkers and avoidance was negatively associated with risk taking in low risk drinkers. This further supported the notion that high risk drinkers are characterised by an increased vulnerability to subsequent losses of control, whereas low risk drinkers are characterised by increased resistance to subsequent losses of control. By measuring two craving dimensions simultaneously, these results offered an enhanced understanding of its influence on subsequent behavioural outcomes as compared to measuring approach alone. Furthermore, the
DART was related to beer consumption in an ad libitum taste test task, validating its relationship with actual drinking behaviour.

Finally, a novel Hypothetical Alcohol-Related Risk Measure (HARM) was developed and psychometrically evaluated following a large online data collection as a complementary risk assessment tool to the tasks already examined. Sexual, injurious and drink-driving risk taking emerged as stable subscales. In particular, elevated sexual risk taking in males, when drinking, suggested that further investigation is required to better understand how the intoxicated initiation of sexual activity by males leads to negative consequences for both genders.

This thesis supported a link between opposing alcohol craving dimensions and risk taking behaviour using a relative balance conceptualisation of alcohol craving, as well as behavioural and self-report assessments of risk. Importantly, a state-based craving assessment and two novel psychometric measures, a laboratory task and a self-report scale were developed and validated as key contributions to the research area of alcohol use and risk taking behaviour.
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Statement of Candidate Contribution

The empirical studies reported in this thesis were designed by the candidate in collaboration with his supervisors, Dr Michael Weinborn and Dr Werner Stritzke. All novel laboratory task and web survey programming was performed by the candidate. Data collection was accomplished primarily by the candidate but also honours students, Sian Gower, Nicola Flood, Courtenay McGill, Phoebe Edgeworth and Kimberly Thuijs. All statistical analyses were conducted by the candidate with guidance from supervisors. This manuscript was written by the candidate with revisions made in accordance with suggestions from supervisors and review panel members Winthrop Professor Colin Macleod and Dr Jonson Moyle.
CHAPTER 1:

General Introduction
Overview

Alcohol is ranked globally as the eighth leading risk factor for death, and third for disease and disability (World Health Organisation, 2011). In Australia, alcohol use disorders affect approximately 3% of females and 4% of males aged 16 to 85 (Australian Bureau of Statistics, 2007-2008). According to the DSM-5 (American Psychiatric Association, 2013), alcohol use disorders are characterised by the presence of any two symptoms from the abuse and/or dependence criteria (e.g., Craving, or a strong desire to use alcohol). Beyond disordered alcohol use, there is also a significant problem in the wider population with the percentage of Australian adults consuming alcohol at unhealthy levels increasing from 18.5% in 2001 to 21% in 2008 (Australian Bureau of Statistics, 2007-2008). Excessive alcohol consumption is not only associated with a variety of negative health outcomes but also structural and functional changes in the brain (Crews & Nixon, 2008; Paljärvi et al., 2012; Sullivan & Pfefferbaum, 2005). Given these and other potentially harmful consequences of prolonged alcohol consumption, it is important to understand the features which facilitate risky alcohol use practices. One such feature is alcohol craving, now also recognised as part of the diagnostic criteria for substance use disorders in the latest edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychiatric Association, 2013). For heavy alcohol users, the experience of craving is thought to influence neuropsychological functioning, subsequently interfering with their decision-making ability, which can then lead to a loss of control (Jentsch & Taylor, 1999). The aim of this thesis was to answer questions regarding the conceptualisation of alcohol craving, the relevance of decision-making in alcohol use, and the potential link between craving and decision-making. Specifically, how is alcohol craving best conceptualised and measured? Does craving influence the decision-making of users, and, if so, does this link between alcohol craving and decision-making manifest differently in groups with
different alcohol use histories? Are presently available laboratory measures capable of capturing alcohol orientated risk taking, and if not, what improvements/modifications could be made? Finally, should self-report alternatives be developed to compliment behavioural tasks for alcohol-orientated risk assessment? These questions were addressed across five studies, presented in five empirical chapters, and consisting of three, partly overlapping, phases.

The first phase was to develop and validate an alcohol craving induction paradigm and was achieved across two studies, Studies 1 and 2. This phase was specifically designed to evaluate a two-dimensional model of craving assessment, composed of both approach and avoidance inclinations, consistent with the Ambivalence Model of Alcohol Craving (Breiner, Stritzke, & Lang, 1999). The assessment of these two dimensions has not been widely used as a method of tracking the transient pattern of alcohol inclinations before and following alcohol cue exposure. This is because traditional forms of craving assessment have ignored the role of mitigating inclinations not to consume alcohol that can exist concurrently to that of the desire to consume alcohol. Study 1, presented in Chapter 2, examined the pattern of opposing craving responses to alcohol cues in high and low risk drinkers. Study 2, presented in Chapter 3, further validated the pattern of these opposing inclination responses by including an alcohol consumption (taste test) paradigm and a control group not exposed to alcohol cues. These first two studies were important to establish that the alcohol induction procedure successfully elicited a craving response, which was necessary to subsequently evaluate its potential influence on decision-making performance.

The second phase consisted of two studies (3 & 4) intended to evaluate the relationship between these two dimensions of craving and decision-making by
examining performance on risk taking tasks following the craving induction procedure. The administration of the decision-making tasks occurred following the craving induction in Studies 1 and 2, however the performance outcomes, as well as their relationship with craving, are reported as Studies 3 and 4 in Chapters 4 and 5, respectively. Performance on well-validated decision-making tasks, the Iowa Gambling Task (IGT) and the Balloon Analogue Risk Task (BART), were evaluated in Study 3. As the IGT did not yield any promising relationships with alcohol craving, it was not included in subsequent studies. Instead, performance on a modified version of the BART was evaluated in Study 4. The purpose of this modification was to replace the original arbitrary task stimuli with that of alcohol stimuli, therefore increasing the relevance of the task to alcohol-orientated decision-making. By enhancing the salience of the task and making it congruent with the craving induction stimuli it was expected that a stronger relationship between craving and decision making would be revealed.

The aim of the third and final phase of this thesis was to extend on the behavioural measures by exploring the utility of an alternative method for measuring alcohol-related decision-making. This was achieved through the online administration of a newly developed self-report measure, which allowed a more direct estimate of real-world risk taking and a more efficient means of data collection. This measure was devised to address the lack of existing scales available to assess alcohol-specific risk taking in the present literature, and to complement the behavioural measures already evaluated in this thesis. This final study (Study 5), presented in Chapter 6, reports the factorial validity of the new measure and its convergent validity with craving as well as widely used self-report risk-propensity measures.
Chapter 7 then summarizes the findings of each study, discusses the implications, considers strengths and limitations of the methods, and outlines future directions based on the series of studies presented in this thesis.

**General Review**

The rationale for the studies presented in this thesis was dependent on prominent motivational and neurobiological models of substance use behaviour. Furthermore, the methodological design drew heavily from studies that have assessed subjective alcohol craving. Relevant contributions from the literature regarding these topics are discussed in the remaining sections of Chapter 1.

**The Ambivalence Model of Alcohol Craving.** The multidimensional Ambivalence Model of Alcohol Craving (Breiner et al., 1999) proposes that alcohol craving consists of separate approach and avoidance dimensions which can exist concurrently. Breiner et al. (1999) argued that the inclination to approach and consume alcohol is fundamental to alcohol use disorders. However, they also argued that exclusively focusing on this process is too restrictive when considered in the context of treatment strategies, which primarily focus on reinforcing or developing the strength of an avoidance inclination. The premise of this model is consistent with earlier notions of separable motivation systems (Gray, 1987a, 1990). Gray (1982, 1987a) proposed that two systems underlie behaviour and affect, the behavioural activation system (BAS) which is an appetitive system characterised by sensitivity to reward, and the Behavioural Inhibition System (BIS), which is an aversive system characterised by sensitivity to punishment. When activated, the BAS, like approach inclinations, can lead to the pursuit of reward (alcohol use), whereas activation of the BIS, like avoidance inclinations, can lead to the evasion of punishment (the aversive states associated with alcohol use).
The principles of the Ambivalence Model are also consistent with the neurosensitization account of craving (Anton, 1999; Robinson & Berridge, 1993) where an imbalance occurs between the strength of pathways in the brain that are responsible for processing reward (approach) and the strength of pathways involved in regulating inhibitory control (avoidance). This is supported by recent evidence that separate neural systems are responsible for approach and avoidance (Levin et al., 2012). Neurosensitization refers to a process of repeated activation of reward circuitry such as the amygdala and nucleus accumbens via substance use. These circuits are thought to become sensitized with continued alcohol use, which leads to a heightened susceptibility for subsequent activation, particularly when exposed to alcohol cues. This process is thought to overwhelm opposing inhibitory pathways located in the prefrontal cortex which leads to diminished control over alcohol approach behaviour (Bechara, 2005; Jentsch & Taylor, 1999).

Approach and avoidance inclinations as conceptualized by the Ambivalence Model are analogous to these neurobiological pathways. They exist simultaneously and thus can ‘compete’ with one another. In order to understand this dynamic balance between approach and avoidance, each dimension needs to be independently quantified so that researchers can better estimate to what extent complex motivational craving states influence whether the individual will drink or not drink, or stop drinking once a drinking episode has begun (Stritzke, McEvoy, Wheat, Dyer, & French, 2007). According to the Ambivalence Model, comprehensive craving assessment considers both the approach inclination, whilst also accounting for the influence of a simultaneous inclination to avoid alcohol which could arise from a variety of factors such as alcohol availability or awareness of the negative consequences of use (e.g. hangover).

Kavanagh et al. (2013) argued that “desires to control drinking should be distinguished from desires or urges to drink” (p. 3). Consistent with this idea, such opposing desires
would presumably attach a weight to an approach inclination. That is, they would strengthen or not impede an approach inclination if the avoidance inclination is low, or weaken and counteract an approach inclination if avoidance is high. For example, an individual who experiences an intense approach inclination with no avoidance inclination is different from an individual who experiences the same magnitude of approach but also experiences an equally intense avoidance inclination. If only the approach inclination in these two individuals is measured, they appear the same. This is problematic because such an assessment would fail to detect and quantify the ambivalence experienced by the second individual, which may be a critical factor in subsequent drinking behaviour and treatment readiness and engagement (DiClemente, Schlundt, & Gemmell, 2004; W. R. Miller & Tonigan, 1996).

Measuring avoidance quantifies its potential weight on the approach inclination and offers a critical contribution to measurement of the craving construct by providing a more accurate means to estimate the net approach inclination. From this perspective, craving is best quantified by considering the balance of the restraining influence of the avoidance inclination against the power of the approach inclination. An advantage of evaluating both inclinations simultaneously is that it allows clinicians to better understand the relative weight that individuals assign to the positive and negative outcomes of alcohol consumption. Acknowledging these weights is essential for resolving ambivalence in widely adopted addiction therapies, such as motivational interviewing (W. R. Miller, 1983). Motivational interviewing strategies involve the facilitation of an intrinsic motivation to change alcohol consumption behaviour in a client (W. R. Miller & Rollnick, 1991). For this therapy to be effective, the client’s hesitation to change (or ambivalence) must be recognised and resolved through the provision of feedback on the risk and harm of the continuation of maladaptive drinking behaviour (W.R. Miller, Andrews, Wilbourne, & Bennett, 1998). This, in effect,
enhances avoidance and thereby reduces the imbalance created by elevated approach inclinations.

An imbalance can also occur within implicit, automatic alcohol-related cognitions associated with craving (Dickson, Gately, & Field, 2013). For example, alcohol dependent individuals, compared to controls, have showed significantly weaker implicit negative alcohol associations, despite sharing similar implicit positive alcohol associations (Dickson et al., 2013). That is, for alcohol dependent individuals, implicit positive alcohol associations outweighed weaker implicit negative associations. In contrast, for controls, who showed similar levels of implicit positive associations, these were balanced by stronger implicit negative associations.

Consistent with Tiffany’s (1990) cognitive theory of automatic and non-automatic processes in drug use behaviour, avoidance can be characterised as the impedance of an automatic approach inclination. According to this account, substance use behaviours are rapid, uninitiated, efficient, and occur without intention. Tiffany argues that outside of unexpected environmental conditions that may block substance use behaviours (e.g., bottle shop is closed), effortful non-automatic cognitive processes may be activated as an explicit attempt to prevent or counteract substance use plans. Breiner et al., (1999) argue that this counter-activity represents the experience of ambivalence, which is the conflict between simultaneous activation of opposing approach and avoidance inclinations. This concept of conflicting activations is also consistent with Gray (1987), who specified that interactions between opposite and concurrent motivation systems might be better characterised by a balance or summation.

Evidence for the validity of the Ambivalence Model also comes from the application of the Approach and Avoidance of Alcohol Questionnaire (AAAQ, McEvoy, Stritzke, French, Lang, & Ketterman, 2004). This 20-item measure was first
validated in non-clinical student samples from Australia and the United States (McEvoy et al., 2004). It revealed a three-factor solution (using 14 items) including two approach factors, mild (labelled inclined/indulgent) and intense (labelled obsessed/compelled), as well as an avoidance factor (labelled resolved/regulated). This structure was later replicated in a sample of patients being treated for dependence (Klein and Anker (2013). By contrast, two studies (Klein, Stasiewicz, Koutsky, Bradizza, & Coffey, 2007; Schlauch et al., 2013b) that investigated the original 20-item version of this measure in alcohol dependent outpatients found a best fit for a two-factor solution comprised of approach and avoidance suggesting that the two dimensions can be assessed without the need to distinguish between mild and intense approach inclinations. The relationship between the two opposing craving dimensions has been found to be positive which, in line with the model, suggests they can occur concurrently.

Using the AAAQ, Klein et al. (2007) found that, after controlling for avoidance, higher approach inclinations were related to dependence severity, and higher avoidance was related to greater time since last drink and fewer drinks in the past week. More recently, Schlauch et al. (2012) found that the approach and avoidance dimensions of the AAAQ were uniquely associated with treatment engagement and outcomes in alcohol dependence. That is, avoidance positively correlated with number of sessions attended, and approach was negatively correlated with days abstinent and positively correlated with drinks per day. Similarly, Klein and Anker (2013) found that while avoidance was not reported to show a relationship with abstinence, higher approach was significantly associated with decreased abstinence in an outpatient sample. Avoidance in this study did, however, positively correlate with days since last drink. Klein and Anker also found that the Penn Alcohol Craving questionnaire (PACS), which has good psychometric properties (Flannery, Volpicelli, & Pettinati, 1999; Rosenberg & Mazzola, 2007), was strongly positively correlated with both the AAAQ mild and intense
approach dimensions, and, less strongly, albeit significantly, negatively correlated with the avoidance dimension.

In a sample of alcohol dependent patients in treatment, Stritzke et al. (2007) examined AAAQ approach and avoidance profiles in three subgroups who were categorised as high lapsers (used alcohol daily or most days of the week), low lapsers (used alcohol between 2-3 times a month), or abstainers (used no alcohol during treatment). Low lapsers typically exhibited a profile of ambivalence - that is scoring highly on both approach and avoidance. By contrast, high lapsers exhibited a profile of dominant approach compared to avoidance, whereas abstainers exhibited a profile consistent with dominant avoidance compared to approach. AAAQ data from Dickson et al., (2013) also shows that alcohol dependent patients have been found to exhibit significantly elevated ratings of avoidance and intense approach inclinations compared to a control group. This is confirms that these inclinations are experienced more intensely in those with an alcohol use disorder and is consistent with newly added DSM-5 criteria. Schlauch et al. (2013b) further explored clinical profiles using the 20-item AAAQ in a large patient sample diagnosed with mental illness and an alcohol use disorder (97% with dependence). This was the first study to examine the relative impact of avoidance on approach over a longitudinal period of treatment-seeking of two, four, and six month intervals. The authors found that avoidance moderated approach inclinations such that the relationship between approach and subsequent drinking was attenuated. Furthermore, decreased drinking over time was associated with high avoidance and low approach, consistent with the Ambivalence Model. At baseline, avoidance was also positively correlated with almost all the negative drinking-related consequences.
The literature to date confirms that avoidance not only consistently yields significant associations with important drinking outcomes alongside approach but is often either the only correlate, accounts for unique additional variance to that of approach, or moderates the effect of approach on drinking behaviour. Therefore, when researchers account for this underrepresented component of alcohol craving alongside more traditional approach inclination measurements, valuable information is gathered that can help explain the motivational and behavioural profiles of maladaptive drinking. These findings suggest that avoidance makes a critical contribution to the relative strength of alcohol craving and its association with alcohol use or non-use.

**Craving and Cue Exposure.** Studies examining approach and avoidance craving dimensions have recently begun to explore how these dimensions operate in the presence of alcohol cue exposure. For instance, approach and avoidance as measured by the AAAQ have both been found to be uniquely associate with negative and positive affect, which are argued to be present before, during, and after craving episodes, and also potentially influence the course of the craving state (Schlauch, Gwynn-Shapiro, Stasiewicz, Molnar, & Lang, 2013a). Specifically, increased negative affect is thought to encourage the inclination to indulge (i.e., approach alcohol) in order to compensate for the negative affective state. Conversely, increased positive affect is thought to reduce consumption because the affective state is more manageable (i.e., a coping strategy is not required). Results from a cue-reactivity study in treatment seeking individuals were consistent with this pattern showing that higher negative affect and lower positive affect were related to increased approach inclinations for alcohol, whereas higher positive affect but not negative affect was related to increased avoidance inclinations for alcohol (Schlauch et al., 2013a).
However, what has not been addressed in these studies is the *dynamic change* in these dimensions in response to alcohol cue exposure over an acute interval. That is, the *difference* between approach and avoidance both prior and following cue exposure and hence the change in the *relative strength* of each inclination following cue exposure has not been assessed. By doing this, motivational states can be better estimated with respect to the presence or absence of ambivalence.

Klein et al. (2007) used an alcohol cue exposure procedure in a study which involved a single administration of the AAAQ while using a three-item traditional self-report approach scale prior to and after exposure, and also monitoring salivation during exposure, to assess cue reactivity. They found that together, approach and avoidance as measured by the AAAQ accounted for a significant amount of variance in the cue reactivity measures. Specifically, a total of 64% of the variance was accounted for in the three-item approach scale at baseline, and 51% post cue exposure, as well as 7% of the variance in salivation. However avoidance did not contribute a significant amount of unique variance to these measures once approach was controlled for. It is important to note, though, that following the cue exposure craving was only reassessed using a single dimension approach scale but the avoidance dimension was not reassessed. Therefore, only changes in approach could be assessed but the changes in dynamic balance (i.e., the change in relative strength) between approach and avoidance in response to cue exposure could not be quantified.

The AAAQ has also been used in a recent study investigating automatic alcohol inclinations involving implicit assessment of response to alcohol stimuli (Barkby, Dickson, Roper, & Field, 2012). Avoidance as measured by the AAAQ was not found to correlate with automatic measures of alcohol avoidance on a stimulus-response compatibility computer task, where participants were instructed to simulate approach
and avoidance movements toward alcohol stimuli. However, avoidance was significantly negatively correlated with automatic approach inclinations. Furthermore, intense approach as measured by the AAAQ (obsessed/compelled subscale) displayed a significant positive relationship with automatic approach inclinations in alcohol dependent individuals (Barkby et al., 2012). That is, only intense - but not mild - approach as measured by the AAAQ was associated with automatic approach behaviour. This is consistent with the neurosensitization account given that intense (not mild) craving results from increased neurosensitization, which in turn leads to more automatic approach behaviour where control is automatically overwhelmed. However, explicit avoidance (a top-down process) was negatively associated with automatic approach (a bottom-up process), which is also consistent with neurobiological models of craving. Specifically, explicit avoidance inclinations are less easily overwhelmed and thus impede the automatic approach inclination. Therefore it is clear that if one only measures explicit approach, the important moderating role of explicit avoidance cannot be estimated.

While there are multiple lines of evidence supporting the utility of assessing both approach and avoidance craving inclinations, the practical implications of doing so remain challenging. Perhaps most importantly, as craving is characterised as a state rather than trait (Oslin, Cary, Slaymaker, Colleran, & Blow, 2009; Shiffman et al., 1997), it is necessary to measure it at intervals throughout an exposure session. Multiple measurement points are necessary to establish changes from baseline, conduct manipulation checks and ensure maintenance over a period of time. In a recent study, Jones, Rose, Cole, and Field (2013) administered the AAAQ before and after cue exposure as part of an investigation looking at subsequent disinhibition and laboratory alcohol consumption in heavy social drinkers. They found significant increases in approach subscales but no change in the avoidance subscale in response to cue
exposure. However, the craving effect was reported to diminish prematurely in this study possibly, in part, attributable to the lengthy and repeated assessments (14-item AAAQ plus two other measures). These findings by Jones et al. show initial support for the independence of the approach and avoidance AAAQ dimensions, as well as their reactivity to alcohol cues. However, issues with the craving manipulation strength over time in the Jones et al. study point toward the need for a briefer assessment of approach and avoidance dimensions for repeated administration.

The AAAQ with its multi-item format limits its applicability in cue exposure designs and thus single-item scales would be more appropriate when assessing approach and avoidance craving dimensions pre- and post-alcohol cue exposure. Typically, multi-item/dimensional scales are associated with a variety of drinking outcomes (e.g., Anton, Moak, & Latham, 1996; K. R. Connolly, Coffey, Baschnagel, Drobes, & Saladin, 2009; Drummond & Phillips, 2002) and possess superior psychometric properties to single-item measures (Rosenberg, 2009). However, some studies have reported high correspondence between single-item and multi-item/dimension scales (Klein et al., 2007; Ooteman, Koeter, Vserheul, Schippers, & van den Brink, 2006), and recent reviews on craving measurement did not report an advantage in predictive utility of one form over the other in terms of alcohol dependence or related drinking outcomes (Kavanagh et al., 2013; Rosenberg, 2009). Such a simplified measurement strategy reduces the likelihood of fatigue and has the added utility of allowing the calculation of the relative balance between approach and avoidance over time. This thesis extended on the work of Klein et al. (2007) by investigating the effect of alcohol cue exposure on approach and avoidance but with the use of a single-item scale for each of the opposing dimensions, so that both inclinations can be tracked over time while limiting the interference of lengthy assessment procedures.
Single-item Assessment of Approach and Avoidance Inclinations. There is extensive literature to support the use of single-item approaches to measure unidimensional models of craving when the aim is to assess changes in craving over multiple time points. Furthermore, they have been found to be highly correlated with multi-item scales and drinking outcomes (Ooteman et al., 2006; Richardson et al., 2008). Kambouropoulos and Staiger (2001) argued that single-item measurement is a generally accepted strategy and is supported by a broad range of studies indicating it is effective and reliable for assessing alcohol craving (e.g., Coffey, Saladin, Libet, Drobes, & Dansky, 1999; Coffey, Stasiewicz, Hughes, & Brimo, 2006; Payne et al., 1992; Pomerleau, Fertig, Baker, & Cooney, 1983; Stasiewicz et al., 1997). The most common form of subjective craving assessment is typically presented as a visual analogue scale (Anton & Drobes, 1998; Rosenberg, 2009) which generally range from 1-10 (e.g., Kambouropoulos & Staiger, 2001) or 1-100 (e.g., Bordnick et al., 2008) with descriptors such as ‘craving’, ‘urge’, and ‘desire’ to drink anchoring each end. Participants are required to make a mark at some point along such a scale to indicate the degree to which the chosen descriptor is experienced. This measurement strategy has likely persevered because the construct was long considered a single dimension ranging from weak to strong. According to the Ambivalence Model, this single-item dimension would need to be complemented by a second item to measure avoidance.

Stritzke, Breiner, Curtin, and Lang (2004) utilized a two-item scale (one for approach and one for avoidance) to evaluate craving for alcohol, non-alcohol, food, and cigarette imagery. Approach and avoidance patterns were measured in response to appetitive images and were examined as a function of groups that represented different levels of alcohol and cigarette use. Light drinkers reported higher avoidance ratings for alcohol images than heavy drinkers, and heavy drinkers reported higher approach ratings for alcohol images than light drinkers. This pattern was similar in occasional
versus daily smokers for cigarette images and there were no differences across any of these groups for the control images (i.e., food and non-alcohol). Approach and avoidance inclinations made independent positive and negative contributions respectively in predicting the quantity and frequency of substance use for both alcohol and cigarette users. This thesis provided initial evidence that single-item assessment of approach and avoidance inclinations in a cue reactivity paradigm is a reliable and valid procedure that can be used for multiple substances.

Connolly et al., (2009) similarly collected ratings on two single-item visual analogue scales for approach and avoidance, respectively, but they did so before and after alcohol cue exposure. However, only the post cue exposure ratings were used in subsequent analyses and the change in approach and avoidance from pre- to post exposure was not reported. Thus, previous studies are limited in that both the AAAQ and single-item approach and avoidance measures were not reported before and after the cue exposure. The studies presented in this thesis addressed this limitation by measuring both inclinations both prior and following alcohol cue exposure. This allows any potential change in the dynamic balance between approach and avoidance to be calculated since they are being measured on equivalent scales.

This thesis extended on previous findings by investigating whether dissociable patterns can be observed using self-reported measures of approach and avoidance when a craving state is induced in response to alcohol cue exposure. This was achieved by using a single-item scale for each inclination to monitor relative and dynamic change throughout an alcohol cue exposure in both high and low risk drinkers.

Neurobiological Perspective on Executive Control. Ongoing exposure to substances is thought to produce dopaminergic responses that become progressively larger, and subsequently heighten the salience of the substance, as well as its associated cues and
motivational properties (Koob & Volkow, 2010; Robinson & Berridge, 1993; Volkow, Fowler, Wang, & Swanson, 2004). This process, known as incentive sensitization, is considered a precursor to enhanced alcohol craving that in turn may prompt more compulsive patterns of alcohol-seeking, contribute to a loss of control, and hence influence risky decision-making (Jentsch & Taylor, 1999; Robinson & Berridge, 2000, 2003). This model is supported by observed inhibitory control deficits in animals as a result of long term drug exposure (Jentsch, Olausson, De La Garza, & Taylor, 2002). Importantly, repeated and sustained exposure to alcohol is associated with stimulation and long-term changes in neural pathways and cortical structures, such as the amygdala and frontal lobe circuitry, which are also involved in decision-making and reward processing (Crews & Nixon, 2008; Fein et al., 2002; Fortuna & Smelson, 2008; Hartstra, Oldenburg, Van Leijenhorst, Rombouts, & Crone, 2010; Hsu, Bhatt, Adolphs, Tranel, & Camer, 2005; Koob & Volkow, 2010; Sullivan & Pfefferbaum, 2005), as well as increased craving for a range of substances (e.g., Childress, Mozley, McElgin, Fitzgerald, & et al., 1999; Grant et al., 1996; Myrick et al., 2004; Park et al., 2010).

There is considerable evidence that the ability to voluntarily suppress motivated reward-seeking behaviours is linked to frontostriatal dysfunction (see Jentsch & Pennington, 2014). In drug users, dopamine depletion in the orbitofrontal cortex and striatum (Volkow et al., 2001; Volkow et al., 2004; Volkow et al., 1996) over time is thought to be causally linked to inhibitory control deficits (Jentsch & Pennington, 2014). The relative proximity of the neural regions associated with reward-seeking and inhibitory control, coupled with the premise of underlying incentive sensitization, suggests that craving may be an important moderator in the propensity for risky decision-making.

Specifically, a craving state, depending on the magnitude of the approach and avoidance motivation, can interfere with already vulnerable inhibitory attentional resources (Franken, Rosso, & van Honk, 2003; Noël, Bechara, Brevers, Verbanck, &
Campanella, 2010) as exposure or anticipated exposure to a substance and its cues activate reward pathways in the brain (Franken, 2003). The activation of such pathways is thought to limit the resources available for inhibitory functions, which may increase the likelihood of engagement in risk. Bechara (2005) argued that the amygdala system represents an ‘impulsive’ pathway, responsible for signalling immediate pleasure and pain, whereas prefrontal regions represent a ‘reflective’ pathway responsible for signalling prospective pleasure or pain resulting from current actions. This second pathway enables inhibitive responses. If the reward-responsive impulsive system is conditioned to the desired drug stimulus through some level of neurosensitization, it is thought to override or ‘hijack’ inhibitory or reflective systems responsible for steering decision-making towards avoiding the substance (Bechara, 2005; Noël et al., 2010; Wiers & Stacy, 2006). These neurobiological processes are consistent with top-down failures of cognitive control (Dalley, Everitt, & Robbins, 2011), which are argued to result in the maladaptive perseverance of drug use behaviour (Robbins, Gillan, Smith, de Wit, & Ersche, 2012). This would explain why alcohol abusers tend to persist with maladaptive behaviour despite the high risk for negative consequences. When alcohol users are induced into a state of craving then the activation of reward pathways may compromise the function of inhibitory pathways, which may lead to an association between the magnitude of approach and avoidance inclinations and performance on risk taking decision tasks.

The Ambivalence Model of alcohol craving and the neurobiological processes underlying reward seeking behaviour and self-control in addiction offer important theoretical and empirical grounding for the studies conducted in this thesis. It was intended that the results presented in the following five studies would contribute to the literature by increasing the understanding of how powerful motivational states such as alcohol craving influence subsequent behaviour.
CHAPTER 2 (STUDY 1):
Alcohol Cue Reactivity Conceptualised and Measured within the Framework of
the Ambivalence Model of Alcohol Craving
Craving is a feature long recognised in the International Classification of Diseases (ICD-10; World Health Organization, 1993) as a key symptom in substance use disorders, and it has recently also been added to the diagnostic criteria in the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychiatric Association, 2013). Since craving is now more widely recognised as an important characteristic of substance use disorders, it is vital to evaluate the means by which it is conceptualized and measured.

Alcohol craving has been measured as either a single or multi-dimensional construct (Kavanagh et al., 2013). Measurement of craving from a unidimensional perspective has largely involved a single statement asking individuals to rate their overall level of craving from absent craving to intense craving. However, this approach fails to account for the mitigating influences of a concurrent inclination not to consume alcohol. By contrast, multi-dimensional approaches typically involve scales that either (1) evaluate several components of an approach inclination using multiple items for each (e.g., Alcohol Urge Questionnaire, Bohn, Krahn, & Staehler, 1995; Desire for Alcohol Questionnaire, Love, James, & Willner, 1998; Alcohol Craving Questionnaire, Singleton, Henningfield, & Tiffany, 1994a; Singleton, Tiffany, & Henningfield, 1994b), or (2) evaluate additional, sometimes opposing, dimensions such as an inclination for avoidance of alcohol (e.g., Temptation and Restraint Inventory, Collins & Lapp, 1992; Approach and Avoidance of Alcohol Questionnaire; AAAQ, McEvoy et al., 2004). Multidimensional scales that assess both approach and avoidance inclinations have the ability to estimate the contribution of opposing inclinations on the relative strength of the traditional approach inclination toward alcohol.

The aim of the current study was to evaluate a two dimensional perspective on alcohol craving assessment, whereby the changes in both approach and avoidance
inclinations were measured in response to alcohol cue exposure. The advantage of this assessment procedure is that it enables researchers to estimate the influence of the mitigating avoidance inclination on the approach based inclination. As discussed in Chapter 1, the Ambivalence Model of Alcohol Craving offers a framework for conceptualizing these two dimensions and, importantly, for disambiguating ambivalent and determined motivational craving states.

The Present Study

In order to extend on Stritzke et al. (2004) and recent findings (Barkby et al., 2012; Dickson et al., 2013; Field, Mogg, Mann, Bennett, & Bradley, 2013; Jones et al., 2013; Schlauch et al., 2013b), the current study examined approach and avoidance in a cue reactivity paradigm that implements a pre- and post-assessment procedure so that a baseline can be established and compared to measurement following a craving manipulation. This is the first study to track and report the transient nature of approach and avoidance across time in a cue reactivity paradigm for alcohol in high and low risk drinkers.

Alcohol craving induction procedures are often in vivo, whereby the beverage is presented and engaged with on a sensory level such as sight, smell, and sometimes taste (e.g., Hofmann, Hüweler, MacKillop, & Kantak, 2012; Monti, 1987). However, the mere expectation for consumption is also integral to both alcohol and cigarette craving, suggesting that anticipating alcohol consumption can enhance the effectiveness of an induction procedure (Carter & Tiffany, 1999; Cox & Klinger, 1988; Field, Caren, Fernie, & De Houwer, 2011; Field & Cox, 2008; Kambouropoulos & Staiger, 2009; Litt & Cooney, 1999; Redish, Jensen, & Johnson, 2008; Wertz & Sayette, 2001). The current study implemented a variation on typical cue reactivity paradigms where participants were not only exposed to imagery, but also given the impression that they
might have the opportunity to consume their preferred alcoholic beverage later in the session.

There were two aims for this study. The first was to measure and track approach and avoidance inclinations before and after alcohol cue exposure so that any changes in motivational state could be identified by calculating net craving. The second was to examine these inclinations in groups that represent different levels of at-risk drinkers to explore how changes in motivational profiles differ according to risk status. To achieve this second aim, the current study used the 2009 Australian Government National Health and Medical Research Council (NHMRC, 2009) guidelines of a 14 drinks per week cut-off as a means to distinguish high and low risk drinkers.

In line with neurosensitization accounts, drinkers who represented different levels of prior alcohol exposure were anticipated to demonstrate different patterns of approach and avoidance inclinations in response to alcohol cues. Based on unidimensional (approach only) accounts of craving, assessment of avoidance is irrelevant. According to the Ambivalence Model of craving, the only cue reactivity pattern where avoidance strength does not add important information occurs when:

(1) High risk drinkers compared to low risk drinkers show both a greater increase in approach and a greater decrease in avoidance (assuming similar levels of approach and avoidance from baseline to post exposure). In that scenario, assessment of changes in approach strength alone would be sufficient to distinguish between motivational craving states in high and low risk drinkers.

However, there are at least two alternative cue reactivity patterns where the failure to assess changes in avoidance strength, would result in an incomplete
understanding of the manner in which high risk drinkers differ from low risk drinkers in their craving strength. These are outlined below.

(2) Both high and low risk drinkers would show a similar increase in approach inclinations following cue exposure, but what distinguishes their reactivity profiles is that only high risk drinkers would show a simultaneous decrease in avoidance inclinations. That is, there would be a larger net increase in the weight of approach relative to avoidance in the high risk drinkers as compared to low risk drinkers.

(3) Finally, there is yet another way in which a larger net increase in the weight of approach relative to avoidance from pre- to post-exposure can occur in the high risk drinkers compared to the low risk drinkers. If the relative strength of approach and avoidance differs between the groups at baseline, similar changes in each dimension can result in a different relative balance of approach and avoidance strength across both groups after cue exposure.

For example, if both groups are characterised by higher avoidance than approach inclinations at baseline, but this difference is much smaller in the high risk drinkers, then even with similar changes in each dimension following exposure there would be a larger net increase in approach relative to avoidance for the high risk drinkers. That is, for the high risk drinkers approach could outweigh avoidance after exposure, whereas for the low risk drinkers the increased approach could still be balanced by equally strong avoidance, even if that avoidance diminished following cue exposure.
Method

Participants

Participants were 60 (52% female) undergraduate psychology students aged 18-59 ($M = 21.28, SD = 6.93$) recruited at the University of Western Australia, who were selected from a larger screening sample (as described below). Most participants were Caucasian ($n = 44, 73.3\%$), with 18.3\% ($n = 11$) reporting Asian ethnicity, and the remaining 8.4\% reporting African ($n = 1$) or ‘mixed’ ($n = 4$) ethnicities. Inclusion criteria consisted of a minimum age of 18 years and self-report of at least 8 standard drinks per week. The average number of standard drinks consumed per week (assessed via self-report of quantity/frequency) at screening was $20.09 (SD = 15.23)$. Participants were split into high (15 males, 12 females) and low risk (14 males, 19 females) drinkers based on the NHMRC guidelines of no more than two standard drinks per day on average for both men and women (or 14 drinks per week). This is consistent with recent studies using the same guidelines to establish healthy and excessive drinking criteria (J. M. Connolly et al., 2013). There were 33 participants who reported drinking 14 or less standard drinks per week ($M = 9.84, SD = 4.27$) and considered low risk, with 27 reporting drinking more than 14 standard drinks per week ($M = 32.61, SD = 14.41$) and considered high risk. These groups were equivalent on gender ratio ($\chi^2 = 1.03, p = .311$) and age, $M_{\text{Low}} = 21.03 (SD = 7.78), M_{\text{High}} = 21.59 (SD = 4.27), t = -.31, p = .758$.

Participants were also screened to exclude those who had been diagnosed or treated for substance abuse or dependence.

Materials

**Demographic Questionnaire.** Six items were used to collect information on age, gender, education, ethnicity, country of birth and whether English was a first language. A further item was used to ascertain the participant’s alcoholic beverage preference (beer, premix or wine).
Drinking Behaviour Questionnaire. (DBQ; McEvoy et al., 2004, adapted from Calahan, Cisin, & Crossley, 1969). The DBQ was used as a screening tool to assess alcohol consumption during the last week as a function of the average quantity of standard drinks consumed in one occasion and the frequency of these occasions. Participants were only asked to complete the questionnaire if they had consumed alcohol in the last 3 months. This measure allowed a drinking index to be calculated (frequency x quantity) which estimated the average standard drinks consumed per week. Additional DBQ items were used to determine important neurological exclusion criteria (e.g., epilepsy, schizophrenia, and traumatic brain injury) as well as whether participants had been diagnosed and/or treated for alcohol abuse or dependence.

Avoidance and Approach to Alcohol Questionnaire. (AAAQ, McEvoy et al., 2004). The 14-item Australian version was used in this study and asks about current (i.e. right now) attitudes toward alcohol use and behaviour (i.e. My desire to drink seems overwhelming). This questionnaire generates three subscales; representing mild (inclined indulgent: four items; α = .90) and intense (obsessed/compelled: four items; α = .86) approach inclinations and an avoidance (resolved/regulated: five items; α = .72) inclination (Stritzke et al., 2007). All questions were rated on a scale of 0 to 8 (Not at All to Very Strongly). Because of its length, the full AAAQ is not an appropriate measure for repeated administration during an acute craving induction procedure. For this reason a single item alternative was used to evaluate the craving induction procedure.

Craving: Approach and Avoidance of Alcohol. The measurement of craving involved the use of two questions (Similar to Stritzke et al., 2004), asking about how much the individual wants to drink (approach) or not drink (avoid) an alcoholic beverage. Both questions were rated on a scale of 0 to 8 (anchored with Very weak to
Very strong). Higher scores for the approach item indicated greater approach inclinations, and higher scores for the avoidance item indicated greater avoidance inclinations. Given the psychometric issues with single item measures it was necessary to demonstrate that this measure correlated appropriately with the multi-item AAAQ. The Obsessed/Compelled and Inclined/Indulgent scales were significantly positively correlated with the approach question ($M_{\text{Obsessed/Compelled}} = .67, SD = .02; M_{\text{Inclined/Indulgent}} = .76, SD = .07$) and significantly negatively correlated with the avoidance question ($M_{\text{Obsessed/Compelled}} = -.50, SD = .07; M_{\text{Inclined/Indulgent}} = -.51, SD = .09$) across all measurement points in the session (all $p < .01$). There were no significant correlations with the Resolved/Regulated subscale and approach and avoidance ratings (all $p > .10$).

**Alcohol Craving Induction.** Three classes of alcoholic beverages (beer, premixed and wine) each with multiple choices were available as craving stimuli. These were: Smirnoff vodka, Jim Beam bourbon and Bundaberg rum as premixed options; white and red for wine; and Corona and Pure Blonde for beer. These beverages were selected based on currently popular varieties or brands, ensuring there was one popular imported and domestic option (i.e., Corona and Pure Blonde respectively). The main component of the craving induction consisted of a short film (a separate one for each beverage class, depending on preference). Each film was matched for length, setting, camera angle, and presentation order. Each video was approximately five minutes in length and consisted of an initial phase of still images portraying people drinking in three different settings (outdoors, at home, and in a public bar, see Figure 1) with four images per setting (six seconds per image). This was followed by a video portraying the
opening, pouring, and drinking of the same beverages in the same three settings\(^1\). The videos were presented using VLC Media Player on the Windows 7 operating system.

*Figure 1.* From top left an example of matched screenshots of beer, wine, and premix video and matched images of beer across domestic, public, and outdoor settings.

The layout of the room used for the craving manipulation was carefully arranged to create an atmosphere that would maintain attention on alcohol and give the impression that the participant would be consuming their preferred beverage. An A3-sized poster next to the computer presented photographic images of the preferred beverage having been prepared for consumption (poured in a glass on a picnic table) and wider images of liquor store shelves (i.e., depicting a variety of brands in one image). Also in view was a bar-sized refrigerator. Cartons of the preferred alcoholic beverage choices were stacked next to the fridge to give the impression that large quantities of alcoholic beverages were obtained for the study and stocked in the fridge. All beverages (except the red wine) were cooled and placed next to appropriate drinking glasses to preserve a layer of condensation in order to increase appeal. A silver metal serving tray was used to present the preferred beverage and the glass to the participant.

\(^1\) Increases in approach were not significantly different between those exposed to the beer (\(n = 24\)) and premix (\(n = 26\)) videos. However, those exposed to the wine video (\(n = 10\)) reported lower increases (\(p = .011\)) in approach than those exposed to the beer video.
Post-Craving Induction Tasks. The Balloon Analogue Risk Task (BART, Lejuez et al., 2002) and the Iowa Gambling Task (Bechara, Damasio, Damasio, & Anderson, 1994) were used to assess risk taking. Description of these tasks (page 89) and subsequent analysis of their outcome measures (page 93) can be found in Chapter 4.

Procedure

Screening/Recruitment. Participants completed the DBQ screening measure and a basic demographics questionnaire during tutorial classes. Participants meeting the eligibility criteria were contacted by phone or email and scheduled for participation in the study during the afternoon only (12 noon onwards), as this was considered an acceptable time period for alcohol consumption and is consistent with other studies (e.g., Teunissen, Spijkerman, Schoenmakers, Vohs, & Engels, 2012). These procedures were approved by the University of Western Australia Human Research Ethics Committee.

Laboratory Session. Consenting participants attended the 45 to 60 minute laboratory session where, firstly, they provided responses to the demographic questionnaire in a neutral room. Participants then completed the two-item approach and avoidance craving measure for the first time (Time 1), and were subsequently taken to the induction room (prepared with craving induction materials as described above) where they were seated and advised that they would watch a short video with headphones on. Once the video was completed, participants were told that they may or may not be asked to participate in a taste test at the end of the session, and then proceeded to complete the second two-item approach and avoidance craving measure (Time 2). None of the participants were later asked to participate in an actual taste test, however the purpose of this implied taste test was to induce the anticipation that alcohol was available for potential consumption (thus maintaining the craving state) throughout
the subsequent computerized risk measures, which lasted between 10 and 20 minutes (described in Chapter 4, page 89).

During the computer session, the researcher retrieved the participant’s preferred alcoholic beverage and glass from the fridge, positioned them on a tray, and placed the tray in front of the participant just to the left of the computer monitor. Once the computerized measures were completed, the participants responded to the third two-item approach and avoidance craving measure (Time 3) and the AAAQ, after which they were informed that they would not be required to take the taste test but that they would be remunerated with an additional $5AUD (in conjunction with course credit). Finally, the participant was debriefed.

Results

To evaluate the pattern of change in approach and avoidance inclinations for both groups across the three time points of the craving induction, a 2 x 3 x 2 mixed model ANOVA (Group x Time x Inclination) was conducted with group (low and high risk) as the between-groups factor, and time (one pre- and two post-alcohol craving induction assessments) and craving inclination (approach, avoidance) as the within-participant factors. There was a main effect of time, $F(2, 116) = 31.39, p < .001, \eta_{partial}^2 = .35$, which was qualified by a significant three-way interaction between time, inclination and group, $F(2,116) = 47.1, p < .01, \eta_{partial}^2 = .08$, indicating that the patterns of approach and avoidance inclinations for each group were different over the course of the craving induction (see Figure 2). Main effects of inclination, $F(1, 58) = 2.77, p = .40, \eta_{partial}^2 = .12$, and group $F(1, 58) = 1.14, p = .29, \eta_{partial}^2 = .019$, were not significant.
Figure 2. Mean ratings of approach and avoidance inclinations by group (Low Risk, High Risk) at baseline (Time 1), post exposure (Time 2), and follow up (Time 3).

To follow up the three-way interaction, two 2 x 2 (Group x Time) mixed model ANOVAs were conducted to examine each inclination separately from baseline (Time 1) to post cue exposure (Time 2). For approach, there was only a main effect of time, $F(1, 58) = 64.96, p < .001, \eta^2_{\text{partial}} = .53$. Paired samples t-tests confirmed that both the low risk group, $t(32) = -5.09, p < .05, d = .89$, and the high risk group, $t(26) = -6.58, p < .05, d = 1.27$, showed a significant increase in approach from Time 1 to Time 2, which was maintained at Time 3, $t(32) = -3.85, p < .05, d = .67$, and $t(26) = -5.42, p < .05, d = 1.04$, respectively.

For avoidance, there was also a main effect of time, $F(1, 58) = 19.87, p < .001, \eta^2_{\text{partial}} = .25$, which was qualified by a marginally significant Group x Time interaction, $F(1, 58) = 3.83, p = .055, \eta^2_{\text{partial}} = .06$. Paired samples t-tests showed that the high risk group showed a significant decrease in avoidance from Time 1 to Time 2, $t(26) = 4.77, p < .05, d = 1.04$. 
Examination of effect sizes shows that the decline in avoidance was nearly twice as large in the high risk group as compared to the low risk group. Given that both groups showed similar increases in approach from baseline to post-cue exposure, but could be distinguished only by a differential change in avoidance, this suggests support for scenario (2) rather than scenario (1).

It is also informative to examine the relative strength of approach and avoidance inclinations separately for Time 1 and Time 2 which corresponds to scenario (3). At Time 1, there was a main effect of inclination, $F(1, 58) = 13.34, p < .01, \eta^2_{\text{partial}} = .19$, showing that avoidance inclinations were stronger than approach inclinations for both groups. Although the Group x Inclination interaction was not significant, $F(1,58) = 2.42, p = .125, \eta^2_{\text{partial}} = .04$, paired samples t-tests revealed that the low risk group showed greater avoidance than approach at Time 1, $t(32) = -3.88, p < .001, d = -.67$, whereas for the high risk group this difference between inclinations at Time 1 was smaller and not significant, $t(26) = -1.41, p = .17, d = -.27$. Examination of effect sizes shows that the difference between inclinations at Time 1 was more than twice as large in the low risk group as compared to the high risk group.

At Time 2, the pattern of the relative strength of approach and avoidance inclinations had reversed for the two groups as evidenced by a significant Group x Inclination interaction, $F(1, 58) = 7.50, p = .008, \eta^2_{\text{partial}} = .115$. Paired samples t-tests confirmed that whereas for the high risk group approach was much stronger than avoidance at Time 2, $t(26) = 2.96, p < .01, d = .57$, for the low risk group, approach was still balanced by equally strong avoidance at Time 2, $t(32) = -.77, p = .448, d = -.13$. Thus, the approach inclination for high risk drinkers at Time 1 shifted from being balanced by avoidance to becoming dominant relative to avoidance at Time 2, which
was in contrast to low risk drinkers whose increased approach inclinations were still balanced by avoidance at Time 2. This pattern is consistent with scenario (3).

This change in relative weight can be illustrated by computing approach–avoidance difference scores for Time 1 and Time 2. These difference scores can then be compared to zero to determine if there was any significant deviation in approach or avoidance from a perfectly balanced craving profile. Figure 3 shows that, at Time 1, for low risk drinkers the negative difference score was significantly different from zero, $t(32) = -3.88, p < .001, d = -.67$, showing that the balance between approach and avoidance was tipped in favour of avoidance, whereas for high risk drinkers the negative difference score was not significantly different from zero, $t(26) = -1.42, p = .17, d = -.27$, showing that there was an equal balance between approach and avoidance. At Time 2, while the net strength of approach had increased for both groups, only for the high risk drinkers was there now a positive difference score that was significantly different from zero, $t(26) = 2.96, p < .01, d = .57$, showing that the initial balance at Time 1 between approach and avoidance has tipped in favour of approach. In contrast, for the low risk drinkers there was still a negative difference score at Time 2, but it was not significantly different from zero anymore, $t(32) = -.77, p = .45, d = -.13$. That is, while the net strength of approach had also increased, it was still balanced by an equally strong avoidance inclination.
Figure 3. Mean difference scores for each group across T1 and T2, dashed lines indicate significance from zero (\( **p < .01, ***p < .001 \)).

Discussion

A traditional conceptualisation of alcohol craving argues that it can be adequately measured by assessing approach strength alone (e.g., Kavanagh et al., 2013). However, the present findings showed that opposing avoidance inclinations can change concurrently to approach over the course of a craving induction, and thereby influence the relative net strength of the approach inclination. Moreover, the magnitude of the change in approach was similar in both high and low risk drinkers and thus their reactivity to alcohol cues appeared to be the same when considering approach alone. However, when also considering the avoidance inclination, the different reactivity profiles between each group were revealed.

This pattern of findings was not consistent with the first (1) scenario since both groups exhibited a similar increase in approach but differed in their change in avoidance such that high risk drinkers significantly decreased in avoidance, whereas low risk drinkers only diminished marginally in avoidance from baseline levels. This pattern of craving reactivity is consistent with scenario (2).
Support was also found for the third scenario (3). The relative balance between approach and avoidance for low and high risk drinkers changed from baseline to post cue-exposure. While both groups at baseline reported a greater avoidance inclination, the effect sizes confirmed that the greater strength of avoidance over approach was less pronounced in the high risk group compared to the low risk group. However, after exposure to alcohol cues and despite a similar magnitude increase in approach for both groups, avoidance diminished only significantly for the high risk individuals and relative to this, their approach inclination become dominant. The low risk group on the other hand, were still balanced by an avoidance inclination of slightly greater relative magnitude despite a similar increase in approach to the high risk drinkers.

Thus the change in craving state for the high risk drinkers was characterised by a shift from ambivalence to predominantly approach, whereas for the low risk drinkers the shift was one from predominantly avoidance to ambivalence. That is, the groups could not be distinguished in terms of changes in the approach dimension of craving alone, but differences emerged only when taking into account simultaneous changes in the relative strength of the avoidance dimension of craving. Following the craving induction in the present study, the craving of high risk drinkers was akin to ‘full throttle’ whereas the craving for the low risk drinkers was tempered with one foot on the brake.

This is consistent with Dickson et al. (2013) who found that alcohol dependent individuals showed weaker implicit negative alcohol associations than social drinking controls, despite sharing similar implicit positive alcohol associations during an implicit association test. This imbalance in automatic alcohol cognitions in alcohol dependent individuals compared to the more balanced profile of controls aligns closely with the explicit patterns of approach and avoidance observed in high and low drinkers.
respectively in the present study following cue exposure. Dickson et al. (2013) similarly described the stronger negative alcohol associations observed in social drinking controls in their study as a ‘protective brake’. Based on these findings, avoidance inclinations would be considered more effortful in high risk drinkers as compared to low risk drinkers. That is, when faced with alcohol cues that elicit an increase in approach inclinations, it is easier for low risk drinkers than for high risk drinkers to maintain the balancing counterweight of an avoidance inclination. Dickson et al. (2013) suggested that the failure to develop an automatic negative alcohol association may increase the risk of alcohol dependence. Similarly, the failure to moderate increased approach inclinations during alcohol cue reactivity with at least equally strong avoidance inclinations may facilitate high risk alcohol use.

In contrast, low risk drinkers maintained higher avoidance than approach throughout the craving induction in the present study. This is consistent with the findings by Stritzke et al. (2007) where alcohol dependent patients who were classified as abstainers showed greater avoidance than approach, and those classified as low lapsers were characterised by ambivalence, where the influence of strong approach inclinations was moderated by equally strong avoidance inclinations. Without the moderating counterweight of strong avoidance inclinations, strong approach inclinations were associated with poor treatment progress and frequent lapses among patients (Stritzke et al., 2007). Thus, it is the changing counterweight of avoidance that appears to shift risk status.

The pattern of change in inclination seen in low risk drinkers in the present study, is actually consistent with the pattern found in heavy drinkers in Jones et al. (2013) where there was also significant increase in approach from baseline to post-cue exposure, whereas avoidance remained statistically the same, as measured by the AAAQ. However, only intense approach inclinations were reported as lower than
avoidance inclinations at baseline, whereas mild approach inclinations were consistently higher than avoidance inclinations before and after cue exposure. This suggests that the high risk drinkers in the Jones et al. (2013) study exhibited a motivational craving profile that was characterised by dominant mild approach at baseline when compared to avoidance but dominant avoidance if compared to intense approach inclinations. Following cue exposure however, both mild and intense approach inclinations were dominant. While the baseline profile of relative balance in high risk drinkers in Jones et al. (2013) was consistent with the profiles of both groups in the present study when only considering intense approach inclinations, the pattern of relative change was more similar to high risk drinkers in the present study given that these intense approach inclinations became dominant compared to avoidance following cue exposure. These changes were not discussed in terms of the relative balance in the Jones et al. (2013) paper but by doing so, a more thorough explanation of these complex profiles can be provided.

**Theoretical and Practical Implications**

The current results support two conclusions. Firstly, approach and avoidance inclinations are independent and are differentially sensitive to alcohol cue exposure in a non-clinical sample. Secondly, the magnitude and relative change in these inclinations pre- and post-cue exposure is different depending on the level of prior experience an individual has had with alcohol.

These findings are consistent with the neurosensitization account of substance use (Anton, 1999; Robinson & Berridge, 1993) in that a greater history of alcohol exposure is associated with an increase in a reward orientated, alcohol seeking disposition. By contrast, low risk drinkers exhibit an avoidance response consistent with intact inhibitory control. These findings offer tentative evidence that the neurosensitization process may have been initiated in the present sample. Research
should focus on strategies to strengthen the protective factor of avoidance in vulnerable individuals as it may be critical in preventing the initiation of maladaptive alcohol use patterns.

It has now been shown that exposure to alcohol cues is a sufficient to disambiguate the potentially ambivalent state present in high risk drinkers at baseline to one of dominant approach. Low risk drinkers on the other hand are more likely to experience ambivalence following exposure to alcohol occurs. These differing reactions to alcohol cues suggests there are some important implications for subsequent alcohol use and risky behaviour, which will be explored in further detail in Studies 2 and 3.

Limitations and Future Direction

This was the first study to directly explore how two separable dimensions of craving fluctuate in response to alcohol cues in individuals who differ in risk status. However there were several limitations.

Firstly, risk groups were defined in terms of quantity and frequency of consumption rather than broader risky drinking criteria that capture the consequences of alcohol use. Although the selection criteria were consistent with other studies which classified high and low risk drinkers similarly (e.g., Jones et al., 2013; Stritzke et al., 2004), there are other direct strategies to define alcohol related risk status. To address this limitation in Study 2, risk status was determined based the Alcohol Use Disorders Identification Test (AUDIT; Bohn, Babor, & Kranzler, 1995) which does take into account the broader characteristics of risky alcohol use such as the extent to which it leads to harmful behaviour or dependence.

Secondly, while assessment of avoidance strength relative to approach strength yielded different craving profiles for high and low risk drinkers, actual alcohol consumption in response to alcohol cues was not assessed in the current study. It is unclear if the variation in the approach-avoidance balance in response to alcohol cues
predicts alcohol use post-exposure above and beyond variations in approach inclinations alone. Schlauch et al. (2013b) have already shown that over a longitudinal period, avoidance was a unique contributor to alcohol use but this was examined at a trait level inclination (i.e., AAAQ referring to the last week rather than right now). By determining that avoidance makes a unique contribution to alcohol consumption within a brief window of time would further support its importance in complimenting approach for the purpose of characterising motivational drinking profiles and predicting subsequent behaviour. Therefore, in Study 2, an alcohol consumption task will be administered following cue exposure to directly explore the relationship between motivational craving profiles and immediate subsequent consumption.

Thirdly, in the present study there was no control group where participants were exposed to a similar craving induction procedure but with non-alcoholic beverage cues. Therefore, it is unclear if the pattern of approach and avoidance inclinations in the present study reflect reactivity specific to alcohol cues. This would require the presentation of appropriate control cues which are comparable in appearance, complexity, consumability, distinctive sensory properties, and desirability (Stritzke et al., 2004). Such control cues should be equally arousing to individuals regardless of their drug use history, and therefore differences in general arousability of the cue cannot be confounded with the differences in arousability specific to psychoactive effects due to drug use history. To show that the observed cue-reactivity patterns are specific to alcohol cues, one needs to show that approach and avoidance inclinations for alcohol do not change in response to non-alcoholic beverage cues. Therefore in Study 2, a comparison condition was included that matched the existing craving induction procedure but with non-alcoholic beverages substituted for alcoholic ones. To extend on the present study, Study 2 will replicate the craving induction procedure while including a measurement of alcohol consumption and a comparison group.
exposed to control cues. Furthermore, risk status will be defined according to broader alcohol use characteristics. These changes are designed to further support the integrity of the procedures and continue exploring the utility of Ambivalence Model as valid framework for evaluating alcohol craving.
CHAPTER 3 (STUDY 2)

Validation of the Ambivalence Framework of Alcohol Craving using an Ad Libitum Alcohol Consumption Paradigm
Kavanagh et al. (2013) have argued that the validity and utility of a theoretical conceptualization of craving lies in its ability to predict drinking and its subsequent influence on productivity and functional indices. Consistent with this notion, Study 2 investigated the validity of the Ambivalence Model of Alcohol Craving (Breiner et al., 1999) and its relationship with alcohol consumption. In the present study a laboratory ad libitum taste test was employed as a behavioural measure of alcohol consumption following a craving induction. Specifically, the present study aimed to identify whether characterising transient motivational profiles (i.e., dynamic shifting of approach and avoidance in response to alcohol cues) is related to subsequent alcohol consumption, as indicated by the taste test. If a significant relationship is found between these transient motivational profiles and alcohol consumption patterns, it would add to the evidence base supporting the validity of the Ambivalence Model. A secondary aim of the present study was to replicate, and extend the findings of Study 1, with a focus on strengthening the methodological features and generalizability. This included (1) the identification and definition of low and high risk alcohol users through a measure of alcohol misuse, rather than just measures of quantity and frequency of alcohol consumption; and (2) the addition of a control condition to determine whether the pattern of approach and avoidance of alcohol discovered in Study 1 is unique to an alcohol exposure condition.

Alcohol Exposure and Ad Libitum Alcohol Consumption

Taste test and other consumption methodologies have previously been used to measure the effects of alcohol craving and other alcohol-relevant processing. Evidence for the sensitivity of alcohol consumption measures comes from a number of related research areas. For example, researchers investigating the preferential allocation of attentional resources towards desired stimuli, or attentional biases, have commonly implemented alcohol consumption measures to evaluate the influence of attentional manipulation during alcohol cue exposure. It has been argued in a review by Field and
Cox (2008) that attentional biases and alcohol craving share a mutually excitatory relationship, such that increases in one leads to increases in the other, which likely result in self-administration of alcohol. The positive relationship between approach based craving and attentional biases toward alcohol has since been confirmed by Field, Munafò, and Franken (2009). By using training paradigms, attentional biases toward alcohol can be modified to elicit an avoidance of alcoholic cues in heavy drinkers and abstinent alcoholics (Field & Eastwood, 2005; Schoenmakers et al., 2010). An important instrument for measuring the effect of training paradigms and cue exposure in attentional bias studies has been the bogus taste test (e.g., Fernie, Christiansen, Cole, Rose, & Field, 2012; Houben, Schoenmakers, & Wiers, 2010; Jones et al., 2011; Weafer & Fillmore, 2008). This procedure involves the presentation of an alcoholic beverage (or non-alcoholic beer under the guise of being alcoholic) often alongside a non-alcoholic beverage. A participant is asked to rate the beverage on certain arbitrary characteristics such as sweetness, bitterness and carbonation (if appropriate). The volume or percentage of fluid consumed is the outcome variable. Since the participants believed that the outcome measures were the ratings, it is anticipated that they were not concerned with how much they ingest. The present study used similar methodological principles to investigate the influence of cue-elicited, explicit approach and avoidance inclinations on subsequent alcohol consumption.

Recent studies using such a strategy have shown that alcohol consumption is significantly higher following an alcohol exposure condition compared to a control condition (e.g., Fernie et al., 2012; Jones et al., 2013; Weafer & Fillmore, 2008) and that alcohol consumption during a similar in-lab ‘free drinking’ session is predicted by approach-based alcohol craving (Leeman, Corbin, & Fromme, 2009). Furthermore, Houben et al. (2010) implemented a procedure that paired negative stimuli with alcohol cues which led to reduced alcohol consumption, lower craving and more negative
attitudes toward alcohol when compared to a control condition. Similarly, Field and Eastwood (2005) demonstrated that using an attentional task to train participants to avoid alcohol was associated with significantly less subsequent beer consumption in a taste test than in participants who were trained to attend to alcohol. That is, strategies designed to increase implicit attentional avoidance lead to a reduction in drinking and self-reported approach-based craving. This suggests that both explicit approach and avoidance inclinations toward alcohol during a cue exposure paradigm should predict subsequent consumption.

There has not yet been a study that has investigated the role of the self-reported dynamic change between approach and avoidance inclinations and subsequent alcohol consumption. Most studies implementing the aforementioned taste test procedure have primarily used it to evaluate the manipulation effect of implicit cognitive measures of attentional approach and avoidance, rather than an explicit craving rating assessment. Evaluating whether or not explicit assessment of approach and avoidance provides a unique ability to predict alcohol consumption is an important step in establishing whether the Ambivalence Model of craving can offer a valuable contribution to explaining subsequent behaviour.

Although there is currently limited evidence looking at approach and avoidance craving assessment and subsequent alcohol consumption, one recent study (Jones et al., 2013) did measure approach and avoidance using the AAAQ (Approach and Avoidance of Alcohol Questionnaire) before and after alcohol cue exposure, and administered a subsequent taste test in heavy drinkers. While mild approach inclinations were positively associated with volume of alcohol consumed in the taste test, no relationship was reported between avoidance ratings and the volume of alcohol consumed in the taste test. This contrasts with recent non-experimental findings, where high avoidance
profiles were found to be associated with reduced self-reported drinking over a long period of time (Schlauch et al., 2013b). Given that the Schlauch et al. (2013b) study was implemented over a longitudinal period (6 months) and the Jones et al. (2013) study evaluated a short timeframe, this might suggest that the effects of avoidance require longer to influence alcohol consumption. However, studies that have successfully reduced alcohol consumption within a single laboratory session by training attentional avoidance (e.g., Field & Eastwood, 2005) suggest that the influence of avoidance can also be transient and immediately responsive to alcohol exposure manipulations. Thus, the role of avoidance in subsequent alcohol consumption following cue exposure requires further investigation. In particular, previous studies have not examined the relative balance between approach and avoidance or whether such a conceptualization and assessment can offer a better understanding of subsequent drinking behaviour.

It is important to note that the approach inclination measured in the Jones et al. (2013) study significantly decreased prior to the alcohol consumption task and there were no changes in avoidance throughout the entire session, which is not consistent with the findings of Study 1. It is possible that the distracting nature of an inhibition task (unrelated to alcohol), which was included between the cue exposure and the subsequent taste test in Jones et al., may have interfered with the course of craving and contributed to the premature extinction of approach-based inclinations. Further distraction during the prolonged period between each procedure was also likely to have occurred due to the extended (five minute) assessments involving the AAAQ plus two other measures, which were administered on three occasions (baseline, post-exposure and post inhibition task). The authors attributed the diminished craving effect to the presentation of non-alcoholic stimuli during the inhibition task and the non-dependent, social drinking nature of the sample (Jones et al., 2013). However, it has been demonstrated in Study 1 that changes in approach and avoidance can be maintained
following alcohol cue exposure in a sample created from almost identical criteria (i.e., the high risk drinking group). This suggests that the procedures, rather than the sample used by Jones et al. may have played a greater role in reducing the craving effect.

Importantly, the pattern of decreased avoidance inclinations in high risk drinkers found in Study 1, and the findings of Schlauch et al. (2013b) that low avoidance predicted increased alcohol consumption prospectively, are consistent with the Ambivalence Model which – unlike Jones et al. (2013) – suggests that avoidance should play a role in an ad libitum alcohol consumption paradigm.

The Present Study

The present study was designed to minimize the likelihood of task or delay interference in reducing the effect of the craving manipulation prior to measuring ad libitum alcohol consumption. This was achieved by implementing two single-item scales, one for approach and one for avoidance, anticipated to interfere as little as possible with ongoing craving inclinations. Furthermore, to strengthen the influence craving has on consumption, the taste test in the present study was administered directly after cue exposure which contrasts to the separation of these procedures by the inhibition task, as used by Jones et al. (2013). To simplify the materials and procedures associated with the craving manipulation and taste test, only beer drinkers were recruited for this study.

To increase the likelihood of including individuals who engage in problematic and risky alcohol use, the present study used scores on the Alcohol Use Disorders Identification Test (AUDIT; Bohn, Babor, et al., 1995) to categorize high and low risk drinkers. The AUDIT includes items that measure consumption but also items that capture risk characteristics of alcohol use, such as dependence and harmful consequences. Furthermore, to increase the disparity in risky alcohol use between the
groups, participant assignment in this study was achieved by using low and high cut-off scores (specified in the method), rather a median split (e.g., Stritzke et al., 2004) or a cut-off based on national guidelines (Jones et al., 2013; Study 1).

The present study is the first to utilize a brief assessment of approach and avoidance to monitor alcohol craving pre- and post-alcohol cue exposure, followed directly by a behavioural assessment of alcohol consumption. It can be further distinguished from Study 1 and Jones et al. (2013) in that two groups are created from individuals who exhibit broader alcohol use risk characteristics, rather than simply quantity and frequency of consumption. Importantly and consistent with Study 1, the single-item approach and avoidance scales allow for the calculation of the dynamic and relative balance between the craving inclinations which was not evaluated in Jones et al. (2013). Also in line with Study 1, such an assessment is argued to make a contribution to the alcohol craving and consumption literature by offering a unique perspective on characterising motivational craving profiles which exist prior to drinking.

The present study had three aims. The primary aim was to include a taste test to directly measure the influence of approach and avoidance inclinations on alcohol consumption. Secondly, the study aimed to replicate the pattern of approach and avoidance inclinations found in Study 1 but with individuals who possess broader alcohol risk characteristics. The third and final aim was to include a non-alcohol control condition to determine whether the pattern of inclination change was unique to the alcohol condition.

There were three proposed alternative scenarios with respect to the potential cue-reactivity patterns for high and low risk drinkers in the alcohol condition:
(1) Consistent with Study 1, both high and low risk drinkers would show a similar increase in approach inclinations following cue exposure, but what distinguishes their reactivity profiles is that only high risk drinkers would show a simultaneous decrease in avoidance inclinations. That is, there would be a larger net increase in the weight of approach relative to avoidance in the high risk drinkers as compared to low risk drinkers.

(2) Alternatively, compared to low risk drinkers, high risk drinkers would show both a greater increase in approach and a greater decrease in avoidance, assuming similar levels of approach and avoidance from baseline to post exposure.

(3) A third scenario may also exist if the relative strength of approach and avoidance differs between the groups at baseline, since similar changes in each dimension could result in a different relative balance of approach and avoidance strength across both groups after cue exposure. In that case, and similar to the first scenario, it was anticipated that there would be a larger net increase in the weight of approach relative to avoidance from pre- to post-exposure in the high risk drinkers, as compared to the low risk drinkers.

With respect to post-cue exposure alcohol consumption, the following predictions were made:

(4) Consistent with Fernie et al. (2012) and Jones et al. (2013) subsequent alcohol consumption would be greater in those exposed to alcohol cues.

(5) Given that the magnitude of recent drinking history contributes to the classification criteria of the low and high risk groups, it is expected that those with a higher likelihood of recently elevated alcohol consumption (high risk drinkers) would take the opportunity to drink more than low risk drinkers in the taste test across both exposure conditions. It is also expected that there would be an
interaction between AUDIT group and condition since the influence of alcohol
cue exposure on beer consumption should be stronger in high risk drinkers than in
low risk drinkers.

(6) Approach and avoidance would both be significant and unique predictors of the
volume of the alcoholic beverage consumed in the taste test.

Method

Participants

Participants were 79 (69% female) undergraduate psychology students aged
between 18 and 34 ($M = 19.15, SD = 2.21$) at the University of Western Australia, who
were selected from a larger screening sample (as described below). Most participants
were Caucasian ($n = 56, 70.9\%$), with 16.5\% ($n = 13$) reporting Asian ethnicity, and the
remaining 12.7\% reporting African ($n = 1$) or ‘mixed’ ($n = 9$) ethnicities. Participants
were assigned to the low risk group if they scored between one and seven on the
AUDIT (indicating “low risk” drinking), and to the high risk group if they scored 12
and above on the AUDIT (indicating “risky” to “very risky” drinking) (Babor, Higgins-
Biddle, Saunders, & Monteiro, 2001). Eligible participants also needed to indicate that
they at least “sometimes” drank beer. Participants in both low and high risk groups were
randomly allocated to either an alcohol or non-alcohol (control) craving induction
condition using a random number generator. This resulted in 20 high risk (45\% female)
and 20 low risk (60\% female) participants in the alcohol condition, and 19 high risk
(32\% female) and 20 low risk (65\% female) participants in the non-alcohol condition.
In the alcohol condition, the proportion of males and females was not significantly
different within the low and high risk groups, $\chi^2(1) = 0.90, p > .05$. In the non-alcohol
condition, there were more males than females in the high risk group, and less males
than females in the low risk group, $\chi^2(1) = 4.36, p < .05$. There were no significant
differences in age across the four groups, $F(3, 75) = .78, p = .159$. All participants
provided informed consent before participating in the study and received one experimental credit point².

Materials

As per Study 1, the Drinking Behaviour Questionnaire, Craving items: Approach and Avoidance of Alcohol and the AAAQ were included in the current study. The demographic questionnaire included an additional question to ascertain the participant’s non-alcoholic beverage preference (soft drink or juice). New materials used are listed below.

The Alcohol Use Disorders Identification Test (AUDIT; Bohn, Babor & Kranzler, 1995). The AUDIT is a 10-item self-report measure that was used to categorize low and high risk drinkers. Scores on the AUDIT range from zero to 40. Scores between one and seven categorize low risk drinkers, and scores of eight and above categorize risky drinkers. Scores above 15 are classified as very risky. The cut-off score for the high risk group in the current study was 12, representing at least the top range of the risky drinking category. The AUDIT consists of three subscales: hazardous use (questions 1-3, α=.60), dependence symptoms (questions 4-6, α=.93), and harmful use (questions 7-10, α=.97).³ The dependence symptoms subscale refers to cognitive, behavioural, and physiological symptoms due to alcohol use; harmful use refers to a pattern of drinking already causing physical and psychological damage to an individual’s health; and hazardous use refers to a pattern of drinking associated with a risk of harmful consequences (Bohn et al., 1995).

² Following the experiment, participants also completed an alcohol related version of the Balloon Analogue Risk Task (reported in Chapter 5), and could earn an AUSS5 incentive for task performance.
³ α based on screening data (N=824)
**The Alcohol Craving Induction.** The alcohol craving induction materials remained the same as in Study 1, except that in order to simplify the materials required for the following taste test, only the beer imagery was used in the alcohol condition. A non-alcohol condition was also included whereby two additional still and video montages were available which matched the beer imagery but presented soft drink or juice depending on the participant’s preference. Consistent with Study 1 there was also an A3-sized poster visible which showed the relevant beverage and appropriate beverage cartons stacked next to the fridge.

**The Taste Test.** A taste test was administered as a behavioural measure of alcohol consumption following the imagery/anticipation based craving induction described in Study 1. The experimenter poured 330mL of beer and 330mL of the participant’s preferred non-alcoholic beverage (orange juice, apple juice, Coca-Cola, or lemonade) into two tall beer glasses. These glasses were marked at the 330mL level to ensure accuracy, although this mark faced away from participants. The order of pouring the beer and non-alcoholic beverages was counterbalanced across participants. “Rating sheets” for each beverage were given to participants for them to rate aspects such as flavour and carbonation. Participants were also asked to estimate the percentage of alcohol of the beer they had tasted. Specifically, they were instructed, “Australian beers come in three standard strength categories (low, mid and full) that represent 2.7%, 3.5% and 4.8% alcohol content respectively. Some beers can have higher or lower alcohol content than is typical of Australian beers. In this question please estimate the percentage of alcohol of the beer you have tasted”. There were five response options: Less than 2.7%, 2.7%, 3.5%, 4.8%, more than 4.8%. The alcohol content estimate was analysed to assess whether participants were aware that a non-alcoholic beer had been used for the taste test. Analysis revealed that 85.9% of the sample selected 2.7% or
greater. The brand of beer used was Clausthaler, with an alcohol percentage of 0.45%, classifying it as non-alcoholic (U.S. Customs and Border Protection, 2008).

The reason for using a non-alcoholic beer was to ensure that participants were not at risk of being intoxicated after the experiment. The beer was chosen based on pilot testing, where ten participants blindly compared three non-alcoholic beers, namely Clausthaler (0.45%), Holsten (0.02%), and Coopers (0.7%). Clausthaler was rated on average as containing over 3% alcohol, with only one participant rating it as non-alcoholic. It was also the most popular, as determined by the average volume consumed (90.62 mL) during the pilot testing.

For the taste test, all labels were removed and caps blacked out so the brand was unidentifiable. Using the same procedures as in Fernie et al. (2012), participants were instructed to drink “as much or as little as they like” to make the ratings and were not given a time limit. However, all participants completed the task within 10 minutes. Beer consumption was measured in two ways, as a percentage of the total fluid consumed, which provides a relative measure of alcohol consumption (combined with non-alcoholic consumption), and as the volume of alcohol consumed (mL), which provides an absolute measure of alcohol consumption. This consistent with the existing literature (e.g., Fernie et al., 2012; Jones et al., 2013) and allows for direct comparison.

**Post-Taste Test Task.** Following the taste test, a modified version of the Balloon Analogue Risk Task (BART, Lejuez et al., 2002) was used to assess risk taking. Description of this task (page 119) and subsequent analysis of its outcome measures (page 122) can be found in Chapter 5.

**Procedure**

The same recruitment procedure was used as Study 1 (see pages 24 & 28), except that here the administration of the AUDIT accompanied the Drinking Behaviour
Questionnaire during the pre-screen session which took place in first year psychology classes. Low and high risk drinkers were randomly allocated to alcohol or non-alcohol cue exposure conditions.

The description of the laboratory procedures are identical to those in Study 1 (see page 28) except that here, following the second craving measurement (Time 2), participants were given the taste test after which they completed a third craving measurement (Time 3). Following this, they also completed a modified version of the Balloon Analogue Risk Task (described and reported in Chapter 5).

Results

Descriptive statistics for AUDIT scores and self-reported alcohol use for high and low risk groups in each exposure condition are summarised in Table 1.
Table 1

*Summary Statistics for AUDIT Scores and Self-reported Alcohol Use for Each Group Based on Risk Status and Craving Condition*

<table>
<thead>
<tr>
<th>Variable</th>
<th>High Risk</th>
<th>Low Risk</th>
<th>Main Effect of AUDIT group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alcohol</td>
<td>Non-Alcohol</td>
<td>Alcohol</td>
</tr>
<tr>
<td><strong>AUDIT Total</strong></td>
<td>16.6(^a) 4.18</td>
<td>16.58(^a) 5.07</td>
<td>4.25(^b) 1.94</td>
</tr>
<tr>
<td><strong>Drinks/Week</strong></td>
<td>39.20(^a) 68.11</td>
<td>37.26(^a) 105.93</td>
<td>2.95(^b) 2.53</td>
</tr>
</tbody>
</table>

*Note:* Same superscripts denote no significant difference, different superscripts denote significant difference.

*** *p < .001, * *p < .05*
Craving Manipulation

In order to evaluate the craving manipulation, a 2 x 2 x 3 x 2 mixed-model ANOVA (Group x Condition x Time x Inclination) was conducted with group (low and high risk) and condition (alcohol and non-alcohol) as between-participant factors, and time (baseline, post cue exposure, and post taste test) and inclination (approach and avoidance) as within-participant factors. The assumption of sphericity, examined via Mauchley’s test was rejected; therefore, Greenhouse-Geisser corrected $F$ tests have been reported. The four-way interaction was not significant, $F(1.17, 87.48) = .64, p = .449, \eta^2_{partial} = .01$. There were significant main effects of condition, $F(1, 75) = 5.67, p < .05, \eta^2_{partial} = .07$, time, $F(1.58, 118.52) = 26.88, p < .001, \eta^2_{partial} = .264$, and inclination, $F(1, 75) = 11.64, p < .01, \eta^2_{partial} = .13$, which was qualified by a significant three-way interaction between condition, time, and inclination, $F(1.16, 87.48) = 14.78, p < .001, \eta^2_{partial} = .16$.

Paired samples t-tests showed that for participants in the alcohol condition, there was a significant increase in approach from Time 1 to Time 2, $t(39) = -11.98, p < .001, d = -1.16$, which was maintained at Time 3, $t(39) = -5.13, p < .001, d = - .82$.

Furthermore, these individuals showed a significant decrease in avoidance from Time 1 to Time 2, $t(39) = 5.15, p < .001, d = .60$, which was maintained at Time 3, $t(39) = 3.71, p < .01, d = .44$. For the non-alcohol condition, while there were also slight increases in approach, $t(38) = -3.86, p < .001, d = -.26$, and decreases in avoidance, $t(38) = 2.80, p < .01, d = .23$, from Time 1 to Time 2, examination of the effect sizes show that the magnitude of the effect in the alcohol condition was four times larger for approach ($d_{alcoholT1-T2} = -1.16$ vs. $d_{non-alcoholT1-T2} = -.26$) and over two times larger for avoidance ($d_{alcoholT1-T2} = .60$ vs. $d_{non-alcoholT1-T2} = .23$).
Figure 1 illustrates that, collapsed across both risk groups, participants showed a pattern of increased approach and decreased avoidance from Time 1 to Time 2, with this effect being much more pronounced in the alcohol condition. This demonstrates that the craving induction procedure was effective, resulting in a greater magnitude of change in approach and avoidance in the alcohol condition compared to the non-alcohol condition. The alcohol condition will now be examined.

Figure 1. Mean approach and avoidance inclinations at Time 1, Time 2 and Time 3 in the alcohol and non-alcohol cue exposure conditions with standard error bars.

To test for scenario (1) and determine if a similar pattern exists as in Study 1 for each group in the alcoholic exposure condition, a 2 x 3 x 2 mixed model ANOVA (Group x Time x Inclination) was conducted. Again the assumption of sphericity, examined via Mauchley’s test, was rejected and therefore Greenhouse-Geisser corrected $F$ tests have been reported. There was a main effect of time, $F(1.59, 60.57) = 30.71, p < .001$, $\eta^2_{partial} = .45$, which was qualified by a significant three-way interaction, $F(1.17,
44.60) = 7.77, p < .01, $\eta^2_{partial} = .17$ (see Figure 2). Main effects of inclination, $F(1, 38) = .28, p = .597, \eta^2_{partial} = .01$, and group $F(1, 38) = .067, p = .797, \eta^2_{partial} = .00$, were not significant. Figure 2 illustrates that, in the alcohol condition, both risk groups showed a pattern of increased approach and decreased avoidance from Time 1 to Time 2.

![Figure 2](image)

**Figure 2.** Approach and avoidance inclination means at Time 1, Time 2 and Time 3 for both groups in the alcohol cue exposure conditions with standard error bars.

To follow up the three-way interaction, two 2 x 2 (Group x Time) mixed model ANOVAs were conducted to examine each inclination separately from baseline (Time 1) to post cue exposure (Time 2). For approach, there was only a main effect of time, $F(1, 38) = 140.59, p < .001, \eta^2_{partial} = .79$. Paired samples t-tests confirmed that both the low risk group, $t(19) = -8.46, p < .001, d = -1.89$, and the high risk group, $t(19) = -8.31, p < .001, d = -1.86$, showed a significant increase in approach from Time 1 to Time 2, which was maintained at Time 3, ($t(19) = -3.06, p < .01, d = -.69$, and, $t(19) = -4.16, p < .01, d = -.93$, respectively).
For avoidance, there was also only a main effect of time, $F(1, 38) = 25.94, p < .001, \eta^2_{partial} = .41$. Paired samples t-tests confirmed that both the high risk group, $t(19) = 3.28, p < .01, d = .73$, and the low risk group, $t(19) = 3.94, p < .01, d = .88$, significantly decreased in avoidance from Time 1 to Time 2. This contrasts with the Study 1 findings as the low risk group in Study 1 did not show a significant decrease in avoidance. This makes the current findings consistent with scenario (1) rather than scenario (2) given that both groups showed a significant decrease in avoidance rather than just the high risk group.

Relative Strength of Approach and Avoidance

It is also informative to examine the relative strength of approach and avoidance inclinations separately for Time 1 and Time 2 which corresponds to evaluating scenario (3). At Time 1, there was a main effect of inclination, $F(1, 38) = 18.54, p < .001, \eta^2_{partial} = .33$, and unlike Study 1, there was also a Group x Inclination interaction, $F(1, 38) = 6.56, p < .05, \eta^2_{partial} = .15$. Paired-sample t-tests revealed that the low risk group showed greater avoidance than approach at Time 1, $t(19) = -5.22, p < .001, d = -1.99$, whereas the high risk group showed no difference between inclinations at Time 1, $t(19) = -1.16, p = .26, d = -.41$. Examination of effect sizes shows that the difference between inclinations at Time 1 was more than four times as large in the low risk group as compared to the high risk group.

At Time 2, the pattern of the relative strength of approach and avoidance inclinations had reversed for the two groups as evidenced by a significant Group x Inclination interaction, $F(1, 38) = 5.07, p < .05, \eta^2_{partial} = .12$. Paired samples t-tests confirmed that whereas for the high risk group approach was now much stronger than avoidance at Time 2, $t(19) = 3.76, p < .01, d = 1.34$, for the low risk group, approach was still balanced by equally strong avoidance at Time 2, $t(19) = .29, p = .77, d = .11$. 
Thus, the approach inclination for high risk drinkers at Time 1 shifts from being balanced by avoidance to becoming dominant relative to avoidance at Time 2, which was in contrast to low risk drinkers whose approach inclination was still balanced by avoidance at Time 2. This pattern is consistent with the pattern observed in Study 1 and in line with scenario (3).

As per Study 1 and scenario (3) it was important to examine changes in the relative balance of approach and avoidance inclinations between each risk group in the alcohol cue exposure condition, before and after cue exposure. This change in relative weight can be illustrated by computing approach – avoidance difference scores for Time 1 and Time 2. These difference scores can then be compared to zero to determine if there was any significant deviation in approach or avoidance from a perfectly balanced craving profile. Furthermore, difference scores have also been presented after the taste test (Time 3). Figure 3 shows that, at Time 1, for low risk drinkers the negative difference score was significantly different from zero, $t(19) = -5.22, p < .001, d = -1.15$, showing that the balance between approach and avoidance is tipped in favour of avoidance, whereas for high risk drinkers the negative difference score was not significantly different from zero, $t(19) = -1.16, p = .26, d = -0.26$, showing that there was an equal balance between approach and avoidance. At Time 2, while the net strength of approach had increased for both groups, only for the high risk drinkers was there now a positive difference score that was significantly different from zero, $t(19) = 3.76, p < .01, d = .84$, showing that the initial balance at Time 1 between approach and avoidance had tipped in favour of approach. In contrast to high risk drinkers, while the low risk drinkers have also shifted to a positive difference score, it was not significantly different from zero, $t(19) = .29, p = .77, d = .07$. That is, while the net strength of approach had also increased, it was still balanced by an equally strong avoidance inclination. Figure 3 also illustrates that at no point during the session did either group
in the non-alcohol condition have a positive difference score, thus demonstrating that both risk groups consistently experienced a larger magnitude of avoidance relative to approach.
Figure 3. Mean difference scores for each group in both conditions across Time 1, Time 2 and Time 3 with standard error bars, dashed lines indicate significance from zero (*p < .05, **p < .01, ***p < .001).
Alcohol Consumption

Proportion of Alcohol Consumed Relative to Total Fluid. For the purpose of testing the prediction that a greater proportion of alcohol (relative to total fluid consumed) was consumed in the alcohol condition (4) and the prediction that there would be an interaction between group and condition (5), a 2 x 2 (Group x Condition) between groups factorial ANOVA was conducted. Analysis of the proportion of beer consumed relative to total fluid consumed showed that those in the alcohol condition drank proportionally more beer than those in the non-alcohol conditions across both groups, \( F(1, 75) = 3.54, p = .06, \eta^2_{\text{partial}} = .05 \) (see Figure 4). Although this effect was just outside conventional margins of significance it suggests that prediction (4) was supported. There was no main effect of group, \( F(1, 75) = .14, p = .712, \eta^2_{\text{partial}} = .71 \), and no Group x Condition interaction, \( F(1, 75) = .003, p = .95, \eta^2_{\text{partial}} = .00 \), for the proportion of alcohol consumed.

![Figure 4. Mean percentage of beer consumption out of total fluid consumed each condition across group with standard error bars.](image-url)
In order to assess the prediction that both approach and avoidance are significant predictors of alcohol consumed (6), a hierarchical and a simple linear regression were conducted. Since there was an effect of condition on proportion of beer consumed, the associations of approach and avoidance with alcohol consumption were examined separately for each condition. Firstly, beer consumption was regressed onto approach and avoidance at Time 2 in each condition separately. Approach and avoidance at Time 2 did not significantly predict the proportion of beer consumption in the non-alcohol condition, \( R = .36, R^2 = .13, F(2, 36) = 2.60, p = .09 \) and was only marginally significant in the alcohol condition, \( R = .38, R^2 = .15, F(2, 37) = 3.17, p = .05 \). Examination of standardized beta coefficients in the alcohol condition revealed that approach inclinations (\( \beta = .36, p < .05 \)), but not avoidance inclinations (\( \beta = -.04, p = .814 \)), were a significant predictor. Secondly, beer consumption was regressed onto the Time 2 difference score for each condition which represents the dynamic balance between approach and avoidance and was found to be a significant predictor for the alcohol condition, \( R = .33, R^2 = .11, F(1, 38) = 4.74, p < .05 \), but not the non-alcohol condition, \( R = .19, R^2 = .04, F(1, 37) = 1.43, p = .24 \).

**Alcohol Volume (mL).** For the purpose of testing the prediction that a greater alcohol volume (mL) was consumed by high risk drinkers and that there would be an interaction between group and condition (5), a 2 x 2 (Group x Condition) between groups factorial ANOVA was conducted. Analysis of the volume of beer consumed showed that high risk drinkers drank more beer than low risk drinkers across both conditions, \( F(1, 75) = 5.13, p < .05, \eta^2 = .06 \) (see Figure 5), suggesting that prediction (5) is partially supported. There was no main effect of condition, \( F(1, 75) = .77, p = .38, \eta^2_{\text{partial}} = .01 \), and no Group x Condition interaction, \( F(1, 75) = .25, p = .62, \eta^2_{\text{partial}} = .00 \), for the volume (mL) of alcohol consumed.
In order to assess the prediction that both approach and avoidance are significant predictors of alcohol consumed (6), several hierarchical regressions were conducted. Since the effect of condition on beer volume (mL) consumed was non-significant, the associations of approach and avoidance with alcohol consumption were examined for the whole sample, with any residual variance due to condition controlled for at Step 1 of the regressions. Firstly, beer consumption was regressed onto approach and avoidance at Time 2. Overall, for both groups, approach and avoidance at Time 2 significantly predicted beer consumption, $R = .49$, $R^2 = .24$, $F(3, 78) = 7.70$, $p < .001$. Examination of standardized beta coefficients revealed that approach inclinations ($\beta = .48$, $p < .01$), but not avoidance inclinations ($\beta = -.14$, $p = .248$) were a significant predictor. Secondly, beer consumption was regressed onto the Time 2 difference score which represents the dynamic balance between approach and avoidance and was found to be a similarly strong predictor, $R = .47$, $R^2 = .22$, $F(2, 78) = 10.51$, $p < .001$, $\beta = .52$, $p < .01$. 

*Figure 5.* Mean volume of beer consumption for each condition across group with standard error bars.
Thirdly, as there was a main effect of risk group on beer volume (mL), two separate hierarchical regressions were then conducted to examine whether approach and avoidance predicted beer consumption for high and low risk drinkers separately with condition controlled for at Step 1. For the high risk group, where approach inclinations were higher than avoidance inclinations following the craving induction, Time 2 inclinations significantly predicted beer consumption, $R = .59, R^2 = .35, F(3, 35) = 6.26, p < .01$. Examination of standardized beta coefficients revealed that approach inclinations ($\beta = .39, p < .05$), and avoidance inclinations ($\beta = -.36, p < .05$) were significant predictors. In contrast, for the low risk group, where increased approach was still balanced by avoidance, Time 2 inclinations did not significantly predict beer consumption, $R = .29, R^2 = .08, F(3, 36) = 1.07, p = .38$. Consistent with the prediction (6), approach inclinations predicted alcohol consumption across both conditions and risk groups with avoidance only doing so in high risk drinkers.

To confirm that the two different alcohol consumption outcomes were measuring separate aspects of the behaviour a correlation was conducted between the two. A moderate correlation of $r = .52 (p<.001)$ was calculated, suggesting that the two only share 27% of variance and therefore offer distinct representations of alcohol consumption behaviour.

Lastly, as a supplementary analysis to further validate the use of the single item approach and avoidance scales, correlations were conducted with the AAAQ in the alcohol cue exposure condition. At Time 1, approach was significantly positively correlated with the Inclined/Indulgent ($r = .56, p < .01$) and Obsessed/Compelled ($r = .49, p < .01$) subscales. Avoidance at Time 1 was significantly negatively correlated with the Inclined/Indulgent subscale ($r = -.36, p < .05$) and positively correlated with the Resolved/Regulated subscale ($r = .43, p < .05$). At Time 2, approach was significantly
positively correlated with the Inclined/Indulgent ($r = .68, p < .01$) and Obsessed/Compelled ($r = .48, p < .01$) subscales. Avoidance at Time 2 was significantly negatively correlated with the Inclined/Indulgent subscale ($r = -.46, p < .01$) and Obsessed/Compelled ($r = -.41, p < .05$) subscales.

**Discussion**

In the present study, the inclusion of a non-alcohol condition confirmed that the magnitude of the changes in approach and avoidance were much stronger when participants were exposed to alcohol cues. Also, the response pattern of approach and avoidance in the alcohol condition replicated the findings of Study 1 and further validated the craving induction paradigm as an effective procedure for inducing changes in approach and avoidance. Moreover, the pattern of relative change between approach and avoidance was also replicated, but now in a sample that represented broader high and low alcohol use risk features. Specifically, net craving was characterised by dominant approach inclinations in high risk drinkers once exposed to alcohol and, by contrast, dominant avoidance before and after exposure in low risk drinkers. The primary aim of the present study was to determine whether alcohol consumption would be influenced by exposure to alcohol and related to approach and avoidance inclinations. It was found that exposure to alcohol cues increased the proportion of alcohol consumed relative to the total fluid consumed when compared to a non-alcohol cue exposure condition. In addition, it was shown that approach and avoidance demonstrated predictive utility for alcohol consumption which was complimented by the strong contribution of the dynamic difference score representing the relative balance between the two. These findings further support the conceptualization of alcohol craving according to the Ambivalence Model.
The present study demonstrated that both low and high risk drinkers displayed a pattern of increased approach and a significant decrease in avoidance following alcohol cue exposure, which is consistent with the hypothesized scenario (1), rather than scenario (2). The significant decrease in avoidance after cue exposure observed in low risk drinkers was not observed in Study 1 as low risk drinkers were distinguished by their unchanging avoidance inclination from baseline to post cue exposure.

Consistent with scenario (3), the relative balance between approach and avoidance for low and high risk drinkers differed from baseline to post cue-exposure such that both groups at baseline appeared to be balanced by an avoidance inclination, although this was stronger for the low risk group. However, after exposure to alcohol cues and despite a similar magnitude change in approach for both groups, avoidance diminished for both groups but only for the high risk group did their approach inclination become significantly more dominant than avoidance. The low risk group on the other hand, shifted to be balanced by approach at Time 2 and were trending back toward dominant avoidance by Time 3. In terms of relative balance, low risk drinkers did demonstrate a cue-reactivity pattern dissimilar to high risk drinkers, by maintaining a dominant avoidance inclination before and after a brief equilibrium of approach and avoidance following cue exposure. This pattern suggests a similar resistance to dominant approach as was observed in Study 1.

The control condition experienced significant increases in approach and decreases in avoidance in response to non-alcohol cues. However, the magnitude of change was not as intense as that seen in the alcohol condition as indicated by smaller effect sizes associated with the change from Time 1 to Time 2. Furthermore, it was confirmed that, following cue exposure, approach was significantly lower and avoidance significantly higher in the non-alcohol condition as compared to the alcohol
cue exposure condition. This confirms that while the pattern of inclination change is similar, the magnitude of this change is much greater amongst those who were exposed to alcohol and thus the third scenario (3) was supported.

Consistent with Fernie et al. (2012) and Jones et al. (2013) the proportion of beer consumption (relative to total fluid) in the present study was higher in the alcohol cue exposure condition which suggests that prediction (4) was, in part, supported. There were also significant differences in beer volume (mL) consumed between the risk groups, with high risk drinkers consistently drinking more than low risk drinkers across both conditions indicating that prediction (5), without the interaction, was supported.

The regression analyses demonstrated that approach, but not avoidance, significantly predicted the volume of beer consumption, and that the relative balance of approach and avoidance inclinations following exposure to imagery significantly predicted beer consumption across both conditions. Interestingly, avoidance only significantly predicted beer volume consumed in high risk drinkers, again highlighting the unique pattern of inclination experienced by each group. This shows that prediction (6) was in part supported and although avoidance alone did not uniquely contribute to a significant degree across both groups, accounting for avoidance as part of the relative balance was an equally useful predictor of alcohol volume consumed as both inclinations together, and more than either inclination alone.

Approach significantly predicting both consumption measures across both groups is consistent with others (e.g., Leeman et al., 2009). Avoidance significantly predicting beer volume consumption in the high risk group, across both conditions, is in line with reports that avoidance uniquely predicts recent reductions in frequency and quantity in adolescent drinkers and longer term abstinence in alcohol dependents (Curtin, Barnett, Colby, Rohsenow, & Monti, 2005; Schlauch et al., 2013b). The current
findings suggest that developing avoidance may be more effective in reducing alcohol consumption in high risk drinkers than it would be in lower risk drinkers. The only other study to examine approach and avoidance over time in conjunction with cue exposure and subsequent alcohol consumption did not find a relationship between avoidance and beer consumption (Jones et al., 2013). This could possibly be attributed to the previously mentioned premature diminishment of the craving effect due to prolonged assessment in that study. Thus, the present findings support the utility of a brief avoidance scale in a cue exposure paradigm.

Importantly, it was shown here that the relative balance of approach and avoidance following cue exposure made a statistically significant contribution to subsequent alcohol consumption. This extends Study 1 of this thesis by showing that characterising motivational craving profiles, using a combination of approach and avoidance, represents better utility for explaining subsequent behaviour than approach or avoidance alone. Furthermore, the present study suggests that this can be generalized to individuals who possess broader characteristics of alcohol-related risk than simple quantity and frequency measures.

Interestingly, the significant increase in approach and decrease in avoidance inclinations in the non-alcohol condition indicate that even those in the non-alcohol condition exhibited some generalized reactivity to the cues in the form of alcohol craving. Soft drink and juice arguably possess influential properties in the current commercial context with regard to alcohol. This is because they are often used to encourage young consumers, not unlike the current sample, to pursue alcohol in the form of premixed spirits and cocktails often referred to as “alcopops” (M. C. Jackson, Hastings, Wheeler, Eadie, & MacKintosh, 2000; Kraus, Metzner, & Piontek, 2010). Given that a large variety of alcoholic beverages are mixed with soft drink and fruit
juice to provide a characteristic flavour (i.e., a pineapple Vodka Cruiser or a Jack Daniels and Coca-Cola), it would not be surprising that similarly flavoured non-alcoholic beverages might elicit some desire for alcohol. It should also be acknowledged that the reactivity responses by participants in the non-alcohol condition could also be attributable to the demand characteristics of the craving scale and testing environment in the absence of alcohol cues.

This study used flavoured beverages as control stimuli in the induction procedure as opposed to water, which is much more commonly used (e.g., Gauggel et al., 2010; Jones et al., 2013; Monti, 1987). The reason for this was to present stimuli that possesses similar sensory properties to alcoholic beverages, rather than water which has no distinct colour, taste or aroma, and thus is arguably not a comparable control stimulus (Stritzke et al., 2004). Given that there were stronger similarities between the properties stimuli in each exposure condition, then the previous enjoyment of “alcopops” by some participants may have aroused some alcohol orientated inclinations, even in the non-alcohol condition. Therefore, detecting conditional effects may be more difficult when using non-water stimuli. However it is still important that future studies use stimuli with comparable properties to alcoholic beverages because there needs to be a better understanding of inclinations toward alcohol compared to ecologically valid alternatives such as soft drink and juice. For example, if at a pub or restaurant and choosing not to drink alcohol, a flavoured beverage is a more likely alternative to water, or nothing at all.

Importantly, the current study showed that the relative balance of alcohol craving is useful in characterizing the pattern of inclination between low and high risk drinkers over time. Assessing the dynamic balance of these inclinations is consistent with conceptualizing craving as the relative activation of approach and avoidance
inclinations (McEvoy et al., 2004). By interpreting the data based on this conceptualization, it was revealed that high risk drinkers exhibited a similar pattern as in Study 1 by being more strongly balanced by avoidance rather than approach at baseline, but post-alcohol cue exposure they demonstrated a significant shift toward approach. Low risk drinkers also exhibited a similar pattern to Study 1 participants except that they shifted to be marginally, although not significantly, more balanced by approach at Time 2. This was not maintained and by Time 3 they returned to being more strongly balanced by avoidance, which contrasts with the significant balance toward approach maintained by high risk drinkers. Since there was a second change of direction for low risk drinkers after the taste test, this suggests that the opportunity to consume alcohol may have satiated any existing approach inclinations. Thus at Time 3 the balance of craving had returned to being more strongly balanced by avoidance, as a function of diminished approach and/or increased avoidance due to satiety. Conversely, the opportunity to consume beer in high risk drinkers served to maintain the dominant approach inclination achieved post cue exposure. Field, Hogarth, et al. (2011) have shown that heavier drinkers exhibit an attentional bias toward alcohol when exposed to alcohol cues, in contrast to lighter drinkers who require the prospect of a certain opportunity to consume in addition to such cues in order to exhibit such a bias. This suggests that higher risk drinkers have a lower threshold for experiencing alcohol-reactivity responses due to their heightened sensitivity to cues. This, in part, may explain why in the current study they exhibit a stronger and more sustained approach inclination than low risk drinkers, who appear to show lower sensitivity to the cues and display a more transient response pattern.

When considering these findings within the context of the Ambivalence Model, the pattern of response between the two inclinations suggests that the high risk drinkers in the alcohol condition shift from a state of ambivalence prior to cue exposure to a state
of dominant approach after cue exposure. In contrast, the low risk drinkers in the alcohol condition shift from a state of dominant avoidance prior to cue exposure to a state of ambivalence following cue exposure. The dominant imbalance toward approach experienced by the high risk drinkers following cue exposure is consistent with the notion that approach overcomes avoidance with increasing risk status (McEvoy et al., 2004).

As in Study 1, exposure to alcohol cues appeared to disambiguate the ambivalence experienced by high risk drinkers at baseline, yet served to initiate an inclination conflict in low risk drinkers. The ambivalence experienced by low risk drinkers after exposure in the present study was, however, short-lived as following the taste test, the relative balance of a dominant avoidance inclination was restored. This interpretation presents an interesting comparison to previous findings, as the baseline ambivalence in high risk drinkers is inconsistent with reports that high risk drinkers should exhibit higher approach than avoidance (McEvoy et al., 2004). However the ambivalence exhibited by low risk drinkers following alcohol cues is consistent with earlier reports in college drinkers suggesting that weak negative associations with alcohol serves to diminish avoidance (Ostafin, Palfai, & Wechsler, 2003).

It is promising that alcohol seeking behaviour between exposure conditions was only marginally non-significant when using flavoured beverages as control stimuli. This aspect of the procedure was novel, and offered an initial attempt to extend on previous studies that have found a significant effect of condition on consumption when using water stimuli as a control (Gauggel et al., 2010; Jones et al., 2013; Monti, 1987).

Limitations

There were at least three limitations in this study. Firstly, as the alcohol condition involved the presentation of beer, only beer drinkers were sought. While
participants who self-reported their preferential beer consumption as ‘always’ or ‘mostly’ were prioritized during recruitment, due to sampling limitations. 49.4% of the final sample were ‘sometimes’ beer drinkers. This would likely have reduced the effectiveness of the craving induction and also the desire to consume beer in the taste test. Given the increasing commercial availability of alternative alcoholic beverages, those who predominantly drink beer are becoming more difficult to recruit especially in an undergraduate population consisting mainly of females. Ideally, several alcoholic alternatives should be made available during cue exposure and the taste test; however, this would be difficult to achieve if reflecting the current procedures (i.e., using a non-alcoholic beer) and would require substantially more resources.

Secondly, another sampling drawback was the limited availability of very risky drinkers in the undergraduate population. Nearly half (48.7%) of the recruited high risk group scored between 12-15 on the AUDIT, rather than in the highest risk category (16+), which reduced the disparity between the groups. For example, 40% of those high risk drinkers in the alcoholic condition scored less than 16 which may explain the higher avoidance at baseline than would normally be expected. However, scores of 11 (or even eight), or higher are a considered a suitable cut-off for predicting alcohol related problems (Conigrave & Hall, 1995). Despite the low cut-off criteria in the present study, the effects were robust enough to find a significant difference between the groups on at least one of the alcohol consumption measures, and notably different patterns of craving inclination were also detected.

Thirdly, the relatively low power of the sample due to its size and composition (described above) may have contributed to the absence of main effects and interactions for some of the alcohol consumption and craving measures. However, it should be noted that a number of significant effects were found despite the relatively small groups,
suggesting that these effects are reasonably robust. Importantly, the outcome of the analyses demonstrated that the hypotheses could still be evaluated regardless of the limitations that have been identified.

**Implications and Future Direction**

The implications drawn from these findings offer some broad theoretical and practical considerations.

Firstly, the relative balance between approach and avoidance inclinations appears to be important for characterising risk status. Specifically, an imbalance driven by a dominant approach inclination is related to risky drinking behaviour, while restraint is likely driven by a dominant avoidance inclination in low risk drinkers. This restraint is manifested as a dampened discrepancy between approach and avoidance of alcohol in low risk drinkers following cue exposure. Essentially, low risk drinkers possess a depressed vulnerability to experiencing a dominant approach response because of the influence of the elevated and concurrent avoidance inclination.

Secondly, the current findings showed that increased avoidance predicted lower subsequent alcohol consumption in high risk drinkers only. This is consistent with a longitudinal study by Schlauch et al. (2013b) who found that trait level avoidance attenuated the relationship between approach inclinations and subsequent drinking in those with dependence. These findings suggest that developing the presence of a strong baseline avoidance inclination should be a valuable strategy in reducing drinking in high risk or alcohol dependent individuals. A baseline safety net of avoidance would afford such individuals with additional resistance when they are inevitably exposed to alcohol cues which activate an approach inclination. Certainly drinkers who are recently recovering from dependence would require heightened activation of avoidance to offset the approach response to alcoholic stimuli (McEvoy et al., 2004). The following
motivational state will then be characterised as one of decreased vulnerability to risky drinking behaviour.

As argued by Kavanagh et al. (2013) and consistent with Jones et al. (2013) a demonstration of craving should be reflected in its impact upon functional indices since that would support a departure from typical functioning. It has been demonstrated that alcohol craving does influence subsequent consumption, however there is limited evidence examining its influence on executive functions and how they might serve as a moderator of risky drinking behaviour. Jones et al. (2013) investigated performance on an inhibition task following a craving induction but failed to find an association between craving and inhibition. However the premature extinction of the craving manipulation may have hampered any potential experimental effects. In contrast, the current study was able to demonstrate that the effect of the craving induction was maintained throughout the session which suggests that the procedures used here may have more utility for investigating the influence of craving on executive function.

Increases in disinhibition have been found following cue exposure in detoxified alcoholics (Gauggel et al., 2010) and social drinkers (Adams, Ataya, Attwood, & Munafò, 2013; Weaver & Fillmore, 2012) as well as during an attentional tasks involving alcoholic stimuli (Noël et al., 2007). However, none of these studies examined approach and avoidance patterns or subsequent drinking behaviour. Since it has been demonstrated in both Study 1 and the present study that craving is characterised by a more complex pattern of inclinational profiles, this may have important implications for the subsequent pursuit of rewards and resistance to punishment. Some evidence in the present study suggests that opposing dimensions of craving are differentially associated with subsequent consumption behaviour, but how that translates to broader risk taking is not well understood. Subsequent engagement with alcohol following cue exposure requires a decision-making process, which
involves evaluating and responding to rewards and consequences, rather than simply inhibiting a prepotent response, which has already been studied. No study has yet investigated the relationship between approach and avoidance craving inclinations and subsequent decision-making. It is important to examine whether dimensions of approach and avoidance are associated with any potential effects in the direction of risky drinking via impaired decision-making. As such, Study 3 will build on existing findings by investigating the more complex nature of decision-making in the presence of alcohol craving as conceptualized by the Ambivalence Model of alcohol craving.
CHAPTER 4 (STUDY 3):

Alcohol Cue Reactivity and Decision-Making: Approach and Avoidance of Risk
According to Loewenstein’s Visceral Account of Addiction (2001), powerful, experiential motivational states such as cue-elicited substance craving can continue beyond treatment and have a profound effect on behaviour. This includes destructive behaviour that consists of a lack of concern for the self and others (Loewenstein, 2001). The manifestation of such behaviour may be grounded in the persistence of craving and its capacity to compromise decision-making ability (MacKillop et al., 2010b). To investigate the compromising influence alcohol craving may have on risky decision-making, the present chapter reports the performance on laboratory decision-making tasks following the validated craving induction paradigm reported in Studies 1 and 2. The aim of the present study was evaluate the potential influence that induced alcohol craving may have on the performance of laboratory-based risk measures. Based on the results of the first two studies of this thesis, a strong focus here was to evaluate whether assessing separate approach and avoidance inclinations would improve the understanding of the relationship between craving and risk propensity amongst low and high risk drinkers.

Both the use of and craving for alcohol are known to be associated with reward processing and risk-orientated behaviour (Kambouropoulos & Staiger, 2001; Lawrence, Luty, Bogdan, Sahakian, & Clark, 2009a; Lejuez et al., 2002; MacKillop et al., 2010b; Vuchinich & Simpson, 1998). The reasons why regular alcohol users engage in risky behaviour and how this behaviour might be related to alcohol craving is not well understood. Risky behaviour is the result of a decision-making process by which the pros and cons of various response options are evaluated and the outcome is typically uncertain and unpredictable (Bechara, 2004). Advantageous decision-making, at its most fundamental level, is the ability of an organism to select the most adaptable course of action from a range of possible behavioural alternatives (Fernández-Serrano, Pérez-García, & Verdejo-García, 2011). By contrast and based on Ainslie’s (1975) theory of
impulsiveness and impulse control, disadvantageous decision-making is characterized by making selections that are only marginally beneficial in the short term, whilst sacrificing longer term benefit. If applied to maladaptive alcohol use, poor decision-making is the failure to avoid excessive alcohol use, opting instead to approach it for its immediate reward, regardless of longer term negative consequences (e.g., hangover or injury). Importantly, this decision-making process often occurs prior to a drinking episode, in which case craving would play an influential role in characterizing the motivational equilibrium that precedes alcohol use. Furthermore, alcohol craving has been found to be enhanced following the ingestion of alcohol (Kirk, 2000; Schoenmakers, Wiers, & Field, 2008; Schoenmakers & Wiers, 2010) which likely further facilitates excess consumption due to a diminished lack of control via executive dysfunction.

**Decision-Making in Substance Users**

Simulating risk in the laboratory allows researchers to evaluate decision-making behaviour under different conditions. The Balloon Analogue Risk Task (BART, Lejuez et al., 2002) and Iowa Gambling Task (IGT, Bechara et al., 1994) are laboratory measures that have been widely used to examine risky behaviour, particularly in substance users (e.g., Bishara et al., 2009; Holmes et al., 2009; Miranda Jr, MacKillop, Meyerson, Justus, & Lovallo, 2009). Findings have often revealed performance deficits on such tasks in substance users compared to non-using comparison groups (e.g., Holmes et al., 2009; Johnson et al., 2008; Loeber et al., 2009; Miranda Jr et al., 2009; Noël et al., 2007; Verdejo-García & Bechara, 2009; Xiao et al., 2009). This indicates that maladaptive decision-making and propensity for risk are characteristic of individuals who report high use of psychoactive substances such as alcohol and cigarettes (e.g., Dom, De Wilde, Hulstijn, Van Den Brink, & Sabbe, 2006b; Johnson et al., 2008; Noël et al., 2007). However there is far less research examining the effect that
craving states have on such tasks in substance users. Given that substance craving is considered a key feature of ongoing substance use, its influence on decision-making may have important implications for subsequent behavioural outcomes.

**Alcohol Craving: Approach and Avoidance**

Substance craving is generally regarded as an urge or desire to seek out a substance of choice which has increased salience as a result of past experience or sensitization (Sayette et al., 2000). As described in previous chapters, the Ambivalence Model of alcohol craving (Breiner et al., 1999) extends this approach-only conceptualization to a more complex two-dimensional one composed of both approach and avoidance inclinations toward alcohol. As discussed previously, these two dimensions may also actively compete with one another which can lead to a state of ambivalence. How this ambivalence is resolved depends on whether behavioural decisions strengthen either the approach or the avoidance inclination. Decisions to avoid alcohol may occur in one of two ways. The first is to avoid initiation of use either some of the time or completely, and the second is to discontinue use once a drinking episode has begun. The availability of alcohol cues, particularly following treatment, is likely to draw an individual toward immediate alcoholic reward that ultimately jeopardises their sobriety and the associated long term benefits (MacKillop et al., 2010b). Alcohol cue exposure has already been shown in Studies 1 and 2 to be important in influencing the course of approach and avoidance inclinations. Furthermore it was shown that examining the relative balance of these inclinations between low and high risk drinkers indicates distinctly different motivational states. The influence of these motivational states on subsequent decision-making is yet be explored in low and high risk drinkers, and understanding the potential role of these states offers an important contribution to explaining maladaptive alcohol use and loss of control.
Alcohol Craving and Decision-Making

While the Ambivalence Model for craving was developed specifically to explain motivational states for alcohol use, it may also be useful in explaining broader risky behaviour (such as gambling, sexual risk and performance on laboratory risk measures). The BART is one decision-making laboratory risk measure offering features that provide a potential means to capture behavioural characteristics of approach and avoidance inclinations. Optimal performance on the BART requires the individual to balance maximising potential monetary gain by repeatedly pumping up a simulated balloon (approaching gain), while minimising potential loss by ceasing pumping and instead cashing in the earnings before the balloon bursts (avoiding risk). This is analogous to decision-making during a drinking episode, where the benefits of continued consumption strengthen approach inclinations, but the risk of negative consequences of continued consumption strengthen avoidance inclinations and may prompt disengagement from further consumption. If the outcome measures on the BART show associations with approach and avoidance inclinations then it would demonstrate that alcohol motivational profiles have an important and potentially direct role in explaining broader risk-taking behaviour.

Importantly, there is evidence supporting a relationship between risky alcohol use patterns and increased risk taking as measured by the BART, since impaired performance has been found in those with a history of abuse and dependence, and is associated with risky alcohol use in a community sample (Holmes et al., 2009; Lejuez et al., 2002). Moreover, there is also evidence to suggest that risky decisions may be influenced by the presence of certain mood states. For example, in a study evaluating whether positive urgency is a risk factor for impulsive and maladaptive behaviour, an induced positive mood was found to predict riskier performance on the BART (Cyders et al., 2010). Conversely, negative mood states such as anxiety have been found to
decrease risk taking on the BART (Maner et al., 2007). Furthermore, an investigation into emotion and decision-making found that reappraising induced negative emotions produced increased risk taking on the BART (Heilman, 2010). Inducing stress has also been found to increase risk taking tendencies on the BART in males but not females (Lighthall, Mather, & Gorlick, 2009). These findings suggest that the BART is sensitive to transient mood states, which have been linked to alcohol craving (Willner, Field, & Reeve, 1998). Thus alcohol craving may be related to performance on the BART in alcohol users.

The IGT is another well-validated decision-making task which has been argued to predominantly assess the approach and avoidance of risk and reward (Lowe & Ziemke, 2010). The IGT offers four response options in the form of card decks, two of which are high pay-off but also have high punishment, and two that provide smaller rewards but also have smaller punishments. To perform well on the task a greater proportion of selections from the latter type of deck is necessary. Similar to the BART, the IGT can be argued to assess some form of behavioural approach and avoidance in that it provides individuals with options to both seek reward and avoid punishment. Evidence suggests that alcohol use is related to IGT performance since detoxified and abstinent alcoholics (Dom et al., 2006b; Noël et al., 2007; Noël et al., 2010), and individuals with dependence and binge drinkers (Goudriaan et al., 2010; Johnson et al., 2008; Xiao et al., 2009) all show deficits on the task. There is mixed evidence regarding the long-term relationship of alcohol use to IGT performance, with some reports suggesting that a period of abstinence can improve performance compared to recently detoxified alcoholics (Loeber et al., 2009). Others, however, have found performance deficits even with extended abstinence (Fein, Klein, & Finn, 2004). There is evidence this could be due to grey matter loss which is associated with poor IGT performance in long term abstinent alcoholics (Fein et al., 2006). Moreover, performance deficits have
also been found in those with damage to areas responsible for reward processing, such as the amygdala (Bar-On, Tranel, Denburg, & Bechara, 2003; Bechara, 2003; Bechara, Tranel, & Damasio, 2000). Importantly, the IGT has demonstrated some key associations with alcohol-related behavioural outcomes such as drink driving and early relapse. Specifically, performance on the IGT has been found to be poorer in drinking under the influence (DUI) offenders compared to controls (Kasar, Gleichgerrcht, Keskinkilic, Tabo, & Manes, 2010), and associated with early relapse in individuals with alcohol dependence (Bowden-Jones, McPhillips, Rogers, Hutton, & Joyce, 2005).

Very few studies have examined the effect of transient mood states on the IGT and the findings are mixed. For example Preston, Buchanan, Stansfield, and Bechara (2007) found that induced anticipatory stress had no effect on IGT performance. By contrast, van den Bos, Harteveld, and Stoop (2009) found that after inducing stress, IGT performance was poorer in individuals with higher cortisol levels than individuals in a non-stressed control group.

The only study to administer the BART and IGT after a craving induction (coupled with abstinence) was conducted with nicotine dependent students (Buelow, 2009). This study failed to demonstrate any performance differences between nicotine dependent students and a non-smoking control group. In addition, a regression analysis showed that nicotine craving did not explain any unique variance in either the BART or the IGT. This study used a 32-item unidimensional self-report measure to assess craving, which is arguably not suitable for repeated assessment of state craving. Furthermore, assessment of craving changes from baseline was not conducted, nor was avoidance measured to explore its potential relationship with these tasks. As such, the current study not only investigates the influence of alcohol (rather than cigarettes) on
decision-making behaviour but also includes a multidimensional and concise craving measurement strategy that is capable of tracking craving magnitude over time.

**Cue-Exposure and Executive Disinhibition**

While there is very little research exploring cue-reactivity in relation to the BART and IGT, there are studies which have examined cue exposure and other features of executive function. For example, Muraven and Shmueli (2006) exposed social drinkers to the aroma of their favourite alcoholic beverage or water prior to completing two self-control tasks. Results revealed that those who were exposed to alcohol were less able to withhold an ongoing response when a tone sounded, and experienced earlier physical fatigue when instructed to squeeze a handgrip. Similarly, Gauggel et al. (2010) examined a small sample of patients with alcohol dependence who were exposed to alcohol or water, and found that the former group performed more poorly on a lexical stop-signal reaction time task and reported a stronger urge to drink. Papachristou, Nederkoorn, Havermans, Horst, and Jansen (2012) exposed social heavy and light drinkers to alcohol cues and found that trait impulsivity moderated the craving response. That is, heavy drinkers with poorer response inhibition exhibited a larger craving response.

These results indicate that the ability to exercise self-control during the experience of a craving state may be rendered less effective due the diminished capacity of executive function. Other findings have shown that inhibitory control failures on a modified attentional bias response task were higher in those exposed to alcohol as opposed to a neutral stimulus (Weafer & Fillmore, 2008). This is consistent with earlier reports that alcoholics are faster to respond to alcohol-related words in a ‘go/no-go’ paradigm, which was modified to examine motor response inhibition, shifting of attention, and the influence of alcohol related stimuli on these functions (Noël et al.,
Some have reported no effect of alcoholic stimuli on inhibition tasks (Nederkoorn, Baltus, Guerrieri, & Wiers, 2009) and others have noted a slowing effect when responding to alcoholic stimuli on such tasks (Rose & Duka, 2008)

In light of the findings to date, Weafer and Fillmore (2012) argued that alcoholic stimuli disrupt the mechanisms of behavioural control and facilitates behavioural activation. This is in line with Noël et al. (2007) who posited that drug-seeking behaviour can be attributed to two related processes; firstly, an increase in incentive motivational qualities of the drug and associated stimuli (related to subcortical dysfunction), and secondly, impaired inhibitory control (related to frontal cortical dysfunction) (Goldstein & Volkow, 2002; Lubman, Yücel, & Pantelis, 2004; Moselhy, Georgiou, & Kahn, 2001). This can be considered analogous to the notion of balancing approach and avoidance inclinations. Noël et al. (2007) further argued that the enhanced sensitivity to the motivational properties of alcohol and the impairment of prepotent response inhibition may lead to loss of control in terms of alcohol use. It is argued in the present study that such maladaptive outcomes can be conceptualized as the result of an imbalance between approach and avoidance inclinations.

Importantly, while some of the above studies measured self-reported alcohol craving and implemented an alcohol cue paradigm, only one study to date has evaluated separate approach and avoidance inclinations, which is essential in characterising the dynamic balance of inclinations that characterizes craving states. Jones et al. (2013) used a semi-naturalistic alcohol cue exposure procedure and examined subsequent disinhibition in heavy social drinkers, and measured approach and avoidance inclinations using the Approach and Avoidance of Alcohol Questionnaire (AAAQ). Alcohol cue exposure had no effect on disinhibition compared to a control condition, while disinhibition was positively correlated with both approach and avoidance inclinations. However, as was discussed in Chapters 2 and 3, the procedures of Jones et
al. (2013) study were not considered optimal for maximising the craving response because of lengthy craving assessments.

The Present Study

The current study aimed to examine the potential influence of alcohol craving on decision-making. Specifically, this was the first study to explore the relationship between separate approach and avoidance inclinations in response to alcohol cue exposure prior to the administration of decision-making tasks. This investigation builds on previous studies that have only investigated disinhibition, not administered an alcohol cue-exposure paradigm, or only conceptualized alcohol craving as a unidimensional construct (e.g., Gauggel et al., 2010; Jones et al., 2013; Noël et al., 2007; Papachristou et al., 2012; Weafer & Fillmore, 2012).

To investigate different patterns of craving response on the decision-making tasks, two different types of drinkers were recruited: firstly, high risk drinkers who have experienced repeated and sustained exposure to alcohol and thus are more likely to have initiated the neuroanatomical effects of neurosensitization; and secondly, low risk drinkers who have also been exposed to alcohol but at lower quantities. Despite the high risk drinkers belonging to a young adult student sample, the high binge drinking rates in Australian adolescents (17%, AIHW, 2011) are anticipated to accelerate the effects of neurosensitization. It is the release of dopamine during the binge/intoxication stage of alcohol use that leads to enhanced incentive salience in regular users (Koob & Volkow, 2010). While low risk drinkers may show some susceptibility to the rewarding properties of alcohol in a craving manipulation (Field, Hogarth, et al., 2011; Papachristou et al., 2012), they are unlikely to have initiated the neurosensitization process that is argued to take place in prolonged and heavy users (Robinson & Berridge, 2000, 2003).
There are several key components to the decision-making process that should be present in the tasks designed to measure it. Firstly, the risk of reward or punishment exists simultaneously for each decision; secondly, that some accumulation takes places (small losses and gains contribute to an overall net position); thirdly, and importantly, there is some opportunity to learn, which offers the prospect of improving future decisions. However, the BART in its most commonly administered form (i.e., not the original version) does not have a learning component. This is because the ‘explosion’ schedule for each trial (balloon) is random and participants only have two options; to pump or collect. To address this, the present study used a version of the BART similar to its original form. In this version of the BART (Lejuez et al., 2002; S. Mitchell, Schoel, & Stevens, 2008), the average probability of any balloon popping is related to the colour of that balloon (one of three colours, each associated with a different level of risk) as opposed to the commonly administered, uniformly coloured balloon version which yields no indication of the level of risk on each trial. This variation allows for learning over trials, and more closely reflects the conceptual nature of the different payout structures of the IGT’s four card decks that can also be learned.

The aims of the current study were twofold. The first was to evaluate the relationship between approach and avoidance inclinations toward alcohol and performance on risky decision-making tasks, consisting of outcome measures that are analogous to behavioural approach and avoidance. The second aim was to determine whether this relationship differed between low and high risk drinkers following alcohol cue exposure.

In line with these aims, the following predictions were made:

(1) Consistent with the broad application of the Ambivalence Model and the unique risk approach and avoidance opportunities on the BART and IGT, it
was hypothesized that when high and low risk drinkers are induced into a craving state, (a) approach ratings toward alcohol would be positively associated with approach (riskier) behaviour on both decision-making tasks. This would be indicated by a higher proportions of selections made from disadvantageous decks on the IGT, and increased average pumps/explosions on the BART. It was also hypothesized that (b) avoidance ratings toward alcohol would be negatively associated with approach behaviour on the BART and IGT.

(2) Consistent with the neurosensitization account, exposure to alcohol cues would presumably lead to a more intense craving effect on the cognitive and neuroanatomical resources in the high risk group, as compared to the low risk group, which would result in group performance differences on both the BART and IGT. This would be observed as high risk drinkers exhibiting a greater number of pumps and explosions on the BART and a greater proportion of selections of disadvantageous decks on the IGT, as compared to low risk drinkers.

In the context of evaluating these hypotheses, it is important to note that an increased appetitive inclination for alcohol in heavy drinkers has been shown to increase sensitivity to reward, demonstrated behaviourally on a monetary card sorting task (Kambouropoulos & Staiger, 2001). Moreover, reward sensitivity has been found to predict both state and trait alcohol craving (Franken, 2002; Kambouropoulos & Staiger, 2009). MacKillop et al. (2010b) found that increased trait alcohol craving was significantly associated with increased discounting of monetary rewards, which is consistent with previous studies demonstrating this relationship with respect to state craving (Field, Christiansen, Cole, & Goudie, 2007). This suggests that reward
sensitivity may moderate the effectiveness of a craving manipulation. Therefore, the relationship between self-reported reward sensitivity, alcohol craving, and the risky decision-making tasks was explored and evaluated in the present study. By doing this, any systematic differences in reward sensitivity that might exist between low and high risk drinkers could be controlled for.

**Method**

**Participants**

The same sample in Study 1 (Chapter 2) was used to collect the decision-making data. Refer to page 24 for participant characteristics.

**Materials**

As per Study 1, the demographic questionnaire, Drinking Behaviour Questionnaire (DBQ), the craving items (approach and avoidance inclinations towards alcohol) and the same alcohol craving induction materials were used for the present study (see page 25 for descriptions). New materials are listed below.

**Behavioural Inhibition and Activation Scales (BIS/BAS, Carver and White, 1994).** This 24-item measure asks about everyday responses to different rewarding and aversive situations. These responses are proposed to capture two underlying principle motivational systems, namely an appetitive one (BAS) and an aversive one (BIS), which have been proposed to form the basis for behaviour and affect (Carver & White, 1994). The BAS is derived from 13 items that were used to provide a measure of reward sensitivity in this study and comprises of three subscales, Fun Seeking (FS, $\alpha = .70$), Drive (Dr, $\alpha = .77$) and Reward Responsiveness (RR, $\alpha = .65$) (based on screening sample, $N = 886$).

**Balloon Analogue Risk Task (BART, Lejuez et al., 2002).** The BART (SuperBART, Developed at University of Maryland, provided by Professor Carl Lejuez,
presents a screen-centred virtual balloon attached to a nozzle and two buttons, one directly below the balloon to deliver a pump to the balloon increasing its size marginally, and one to cash-in the earnings for the current balloon. Total earnings are indicated in the bottom right of the screen (see Figure 1). The mouse is used to select either pumping or cashing in. The balloon will increase in size in response to pumping until explosion or cash-in, which then initiates the beginning of the next trial. The balloons are of three colours (Green, Blue, and Red), each representing different levels of risk based on the amount of mean number of pumps until explosion (16, 32, and 64, respectively). Balloon colour and explosion schedule were randomized over 30 trials, but kept consistent for every participant to limit extraneous variability between individuals (e.g., Pleskac, Wallsten, Wang, & Lejuez, 2008). The two outcome measures analysed were the average pumps across all the trials and the number of explosions. A commonly used version of average pumps (adjusted average pumps), whereby the trials in which the balloon explodes are excluded, was not used in this study because it has been argued that such a calculation also excludes trials characterised by riskier behaviour (Vigil-Colet, 2007). Furthermore, studies have yielded that both interpretations produce similar results (e.g., Boronvalova et al., 2009). The BART took approximately five minutes to complete.

**Iowa Gambling Task (IGT, Bechara et al., 1994).** The IGT presents four card decks and a status bar indicating the ratio of debt to gain, accompanied by a numerical value of this amount (the player commences the task with a balance of zero, indicated as being $2000 in credit and $2000 in debt to offset early losses, see Figure 1). The decks are labelled A, B, C, and D and there is a central instruction on the screen directly above them to select a card on each trial. Decks A and B offer higher payouts but large penalties which average out to a -$25 loss per trial, whereas decks C and D offer smaller payouts but with small penalties which average out to a +$25 gain per trial across the
task. Thus decks A and B are considered disadvantageous (high risk) and decks C and D are considered advantageous (low risk). All trials involve an initial gain (indicated by text and a casino-style winning sound) with only some trials involving a loss signalled directly after the gain (indicated by text and a casino-style losing sound). Participants were informed that their aim was to maximise profit, and they were not given any information about the payoff structure of the task or the number of trials. The scoring of the IGT is determined by the ratio of selections from advantageous decks to disadvantageous decks or $(C + D)$ selections minus $(A + B)$ deck selections (Bechara et al., 1994) with a larger score indicating a greater proportion of disadvantageous selections. The task consisted of 100 trials and took around 10 minutes to complete.

Figure 1. Screenshots of the Balloon Analogue Risk Task and Iowa Gambling Task respectively.

Procedure

The screening and recruitment procedure was detailed in Chapter 2 (see pages 49 & 52). The laboratory session for the present study is detailed below.

Laboratory Session. Consent ing participants attended the 45 to 60 minute laboratory session where, firstly, they provided responses to the demographic and the BIS/BAS self-report measures. Participants then completed the craving measure for the first time (Time 1), and were subsequently taken to the induction room (prepared with
craving induction materials as described above) where they were seated and advised that they would watch a short video with headphones on. Once the video was completed, participants were told that they may or may not be asked to participate in a taste test at the end of the session. They then proceeded to complete the second craving measure (Time 2). None of the participants were later asked to participate in an actual taste test, however the purpose of this implied taste test was to induce the anticipation that alcohol was available for potential consumption (thus maintaining the craving state) throughout the subsequent computerized measures. The BART and IGT were both administered in a counterbalanced order. The instructions for the IGT were delivered by the experimenter and the instructions for the BART were delivered on screen. Both sets of instructions involved informing the participants that they would receive a bonus $5AUD if they performed well enough on both tasks as an incentive to follow instructions and remain engaged throughout the task’s duration, which is consistent with other studies (e.g., Lee et al., 2009). During the short break between tasks, the researcher retrieved the participant’s preferred alcoholic beverage and a glass from the fridge, positioned them on a tray and placed the tray in front of the participant just to the left of the computer monitor. Once the computerized measures were complete, the participants completed the third craving measure (Time 3). Following this, they were informed that they would not be required to take the taste test, but that they would be remunerated with an additional $5AUD regardless of their performance (in conjunction with course credit). Finally, the participant was debriefed.

**Results**

**Craving Manipulation**

As detailed in Chapter 2, the craving induction was demonstrated to be successful, in that both groups showed a significant increase in approach in response to
the alcohol induction procedure. Furthermore, high risk drinkers experienced stronger approach and avoidance responses than low risk drinkers, please refer to pages 29-33.

**Decision-Making**

Predictions that (1a) approach would be positively and (1b) avoidance negatively correlated with risk taking were firstly addressed by conducting Pearson correlations between the baseline and post induction craving measures, and the BART and IGT outcome measures (see Table 1). Consistent with Studies 1 and 2, the associations between the relative balance (approach – avoid), where a positive score indicates more dominant approach inclinations and a negative score indicates more dominant avoidance inclinations, and both decision-making tasks have been reported in Table 1.
Table 1

*Pearson Correlations for Low and High Risk Drinkers at Pre- and Post-Craving Intervals between the Balloon Analogue Risk Task, Iowa Gambling task, Approach and Avoidance, and the Relative Balance of Alcohol Craving*

<table>
<thead>
<tr>
<th>Risk</th>
<th>Approach</th>
<th>Avoid</th>
<th>Approach</th>
<th>Avoid</th>
<th>Relative Balance</th>
<th>T1</th>
<th>T2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pumps</td>
<td>.09</td>
<td>-.41</td>
<td>.03</td>
<td>.01</td>
<td></td>
<td>.30</td>
<td>.01</td>
</tr>
<tr>
<td>Explosions</td>
<td>.17</td>
<td>-.32</td>
<td>.17</td>
<td>.04</td>
<td></td>
<td>.29</td>
<td>.08</td>
</tr>
<tr>
<td>IGT Score</td>
<td>.12</td>
<td>.08</td>
<td>.11</td>
<td>.20</td>
<td></td>
<td>.02</td>
<td>-.04</td>
</tr>
<tr>
<td>High</td>
<td>.39</td>
<td>-.27</td>
<td>.39</td>
<td>-.35</td>
<td></td>
<td>.37</td>
<td>.41</td>
</tr>
<tr>
<td>Pumps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explosions</td>
<td>.28</td>
<td>-.28</td>
<td>.33</td>
<td>-.29</td>
<td></td>
<td>.31</td>
<td>.34</td>
</tr>
<tr>
<td>IGT Score</td>
<td>.00</td>
<td>.24</td>
<td>.06</td>
<td>.14</td>
<td></td>
<td>-.13</td>
<td>-.04</td>
</tr>
</tbody>
</table>

*Note.* Correlation coefficients that reached significance (*p*<.05) are displayed in bold, no correlations were significant following a sequential Bonferroni adjustment for each group.

Approach inclinations toward alcohol at baseline and post craving induction were consistently positively correlated with average pumps in high risk drinkers. By contrast, approach inclinations in low risk drinkers were not correlated with average pumps or explosions at either of those time points. However, for low risk drinkers, avoidance at Time 1 was significantly negatively correlated with average pumps. These correlations are consistent with predictions (1a), where high risk drinkers were expected to demonstrate stronger positive correlations with approach than low risk drinkers, and (1b), where low risk drinkers were expected to show a stronger negative correlation with avoidance at baseline than high risk drinkers. Interestingly the correlation between
average pumps and avoidance in high risk drinkers at Time 2 ($r = -.35$) was much stronger than low risk drinkers ($r = -.01$). This shows that the strength of the relationship remains the same as baseline in high risk drinkers after the craving induction, as opposed to the weakening relationship seen in low risk drinkers from baseline to Time 2. The relative balance between approach and avoidance only yielded a single significant correlation at Time 2 in high risk drinkers with average pumps. However, the general pattern of associations show that in low risk drinkers there was a weakening relationship (though not significant) with average pumps from Time 1 to Time 2, while in high risk drinkers there was a consistency of this relationship from Time 1 to Time 2. The IGT showed only very weak associations across all craving measures.

It should be noted that considering correction for the number of correlations, strict levels of significance were not achieved, so these interpretations can only be tentative. Without correction, a number of these correlations could reach significance due to chance alone.

The same correlations in Table 1. were conducted with each deck of the IGT and the same BART outcome measures for each balloon colour, to explore whether the differing risk options on each task were associated with craving. In low risk drinkers, green balloon explosions were significantly associated with T1 Approach ($r = .44, p = .01$), T1 Avoidance ($r = -.37, p = .04$), and T2 Approach ($r = .44, p = .01$). Similarly, green balloon average pumps were associated with T1 Approach ($r = .36, p = .04$), T1 and T2 Approach ($r = .38, p = .03$). Both blue ($r = .35, p = .05$) and red ($r = .35, p = .04$) balloon average pumps were associated with T1 Avoidance. There were no associations in high risk drinkers. None of the IGT decks were associated with craving.
To follow up the correlation analysis, a linear regression was conducted to further evaluate the relationship between approach and avoidance at Time 1 and the BART (average pumps) with both groups collapsed. Since the groups showed differing significant correlations with approach and avoidance at Time 1, an interaction term for each inclination was included at Step 2. The regression analysis is presented in Table 2.

Table 2

Linear Regression with Average Pumps regressed onto Approach and Avoidance

<table>
<thead>
<tr>
<th>Variable</th>
<th>(b^*)</th>
<th>(\beta)</th>
<th>SE</th>
<th>(t)</th>
<th>(p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1 Approach</td>
<td>-.02</td>
<td>-.01</td>
<td>.34</td>
<td>-.05</td>
<td>.963</td>
</tr>
<tr>
<td>T1 Avoid</td>
<td>-.75</td>
<td>-.35</td>
<td>.32</td>
<td>-2.32</td>
<td>.024</td>
</tr>
<tr>
<td>Step 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1 Approach x Group</td>
<td>1.16</td>
<td>.73</td>
<td>.67</td>
<td>1.37</td>
<td>.115</td>
</tr>
<tr>
<td>T1 Avoid x Group</td>
<td>.92</td>
<td>.67</td>
<td>.72</td>
<td>1.60</td>
<td>.177</td>
</tr>
</tbody>
</table>

* Unstandardized beta weight

The linear regression yielded a statistically significant model at Step 1, \(R = .34\), \(R^2 = .12\), \(F(2, 57) = 3.84, p < .05\), and at Step 2, \(R = .40\), \(R^2 = .16\), \(F(4, 55) = 3.66, p < .05\), but with a non-significant \(R^2\Delta\) (\(p = .249\)). Examination of the standardized beta values in Table 2 revealed that Time 1 avoidance negatively predicted average pumps in both groups; however, neither interaction term significantly predicted average pumps. Finally, a multiple regression analysis was conducted to examine the contribution of relative balance (approach and avoidance difference scores) for Time 1 and Time 2 on average pumps. The regression analysis yielded a statistically significant model, \(R = .11\), \(R^2 = .07\), \(F(2, 57) = 3.37, p < .05\). Examination of standardized beta coefficients revealed that the Time 1 difference score (\(\beta = .43, p < .05\)), was a significant predictor but not the Time 2 difference score (\(\beta = -.17, p = .37\)).
While low and high risk drinkers exhibited different patterns of approach and avoidance response to the exposure paradigm with stronger effect for the high risk group (see Chapter 2, pages 29-33), prediction (2) was not supported as there were no group differences on the outcome measures of either decision-making task. Table 3 displays the descriptive statistics and significance tests between the two groups for drinking index, reward sensitivity, IGT total score and BART average pumps, and explosions.

Table 3
Descriptive Statistics and t-tests for Drinking Index, Reward Sensitivity, IGT Score and BART Average Pumps and Explosions in Both Risk Groups

<table>
<thead>
<tr>
<th></th>
<th>Low Risk Drinkers</th>
<th>High Risk Drinkers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(N = 33)</td>
<td>(N = 27)</td>
</tr>
<tr>
<td><strong>M</strong> (SD)</td>
<td><strong>M</strong> (SD)</td>
<td><strong>t</strong> (p)</td>
</tr>
<tr>
<td>Drinker Index</td>
<td>9.84 (4.27)</td>
<td>32.61 (14.41)</td>
</tr>
<tr>
<td>BIS</td>
<td>20.79 (3.60)</td>
<td>19.67 (2.83)</td>
</tr>
<tr>
<td>BAS</td>
<td>38.18 (5.81)</td>
<td>40.46 (6.09)</td>
</tr>
<tr>
<td>IGT Total Score</td>
<td>20.36 (25.39)</td>
<td>23.93 (26.40)</td>
</tr>
<tr>
<td><strong>BART</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Pumps</td>
<td>18.5 (5.05)</td>
<td>17.86 (4.64)</td>
</tr>
<tr>
<td>Explosions</td>
<td>9.94 (3.89)</td>
<td>9.74 (3.94)</td>
</tr>
</tbody>
</table>

While there were no risk group differences on either task, there was a gender difference in the mean number of explosions with males exploding more balloons than females, \(t(58) = -2.30, p < .05, d = -.59\).
Further evaluation of decision-making performance between the groups was explored by acknowledging that there was a learning component on each task. However, there were no group differences in the number of selections from each card deck or the explosions and average pumps for each balloon colour.

Finally, correlations were conducted between the BAS scales and IGT, BART, alcohol consumption and the craving measures in each group. Only avoidance at Time 2 demonstrated significant negative correlations with all of the BAS subscales; Reward Responsiveness ($r = -.35, p < .01$); Drive ($r = -.34, p < .01$); Fun Seeking ($r = -.29, p < .05$); and Total Score ($r = -.29, p < .05$). Furthermore, self-reported alcohol consumption in low risk drinkers was positively associated with Reward Responsiveness ($r = .36, p < .05$) and Fun Seeking ($r = .35, p = .05$). No other correlations were significant, including the association between the BART and IGT ($r_{avpumps} = .05, p = .69$, and $r_{explosions} = .14, p = .29$). However, the IGT score demonstrated a single significant correlation with the BAS total score ($r = -.47, p < .01$) only in low risk drinkers.

**Discussion**

The influence of alcohol craving states on subsequent decision-making performance could have important implications for understanding the maladaptive sequence of behaviours that leads to addiction and abuse. However, in the results of the present study, high risk drinkers showed no indication of impaired decision-making performance due to alcohol craving compared to low risk drinkers. Yet, there is some evidence that examining separate approach and avoidance inclinations could provide a more informative means to understand alcohol users’ engagement in subsequent risky behaviour, compared to examining approach inclinations alone.

The presence of an association between increased approach inclinations for alcohol and increased risk on the BART in high risk drinkers at baseline is supportive of
the first prediction (1a) and indicates that this relationship exists regardless of whether these individuals have been exposed to alcohol or not. However, cue exposure does appear to maintain the strength of this relationship which could potentially exacerbate risky decision-making. By contrast, the low risk drinkers show a strong negative correlation between avoidance and average pumps at baseline which is consistent with prediction (1b), although this correlation disappears following alcohol cue exposure. The positive association between approach and BART performance is consistent with Jones et al. (2013) who similarly found significant positive correlations between both mild and intense approach subscales on the AAAQ, and disinhibition in heavy drinkers before and after alcohol cue exposure. However, Jones et al. also found a significant positive correlation between the avoidance subscale on the AAAQ and disinhibition, which is inconsistent with the negative correlation found between avoidance and the BART in the present study. The direction of the relationship found in Jones et al. (2013) is difficult to interpret but might suggest that the relationship between disinhibition and avoidance may be fundamentally different to that of risk taking and avoidance.

The present findings suggest that the existing presence of an increased avoidance inclination in low risk drinkers offers a protective factor that subsequently reduces risky decision-making. The disappearance of this relationship after cue exposure indicates that the presence of alcohol cues may reduce or eliminate the effectiveness of this protective factor. This may, in turn, lead low risk drinkers to be more likely to engage in risky behaviour, although this was not supported by a significant correlation at Time 2. Interestingly, the regression analysis confirms that avoidance, but not the traditional approach inclination, is a significant predictor of average pumps suggesting that this inclination might be more important in the regulation of decision-making behaviours than approach. Examination of average pumps regressed onto the relative balance of approach and avoidance also suggests that
pre-exposure inclinational disposition may be more critical for decision-making than post-exposure. Importantly, these findings reinforce that measuring the contribution of avoidance provides valuable information that would otherwise be ignored if only measuring an approach inclination.

As no group differences were found in performance on either the BART or IGT following the craving induction, prediction (2) is not supported. This is in line with Papachristou et al. (2012) who similarly split drinking groups into high and low risk drinkers and found no performance differences on behavioural inhibition or a monetary reward sensitivity task. While the current study did not examine a non-alcohol cue exposure condition, evidence from Jones et al. (2013), who did include such a condition, showed there was no exposure effect on disinhibition between groups. These findings suggest that cue exposure and subsequent increases in craving alone may not be sufficient to interfere with increased inhibition or risk taking under laboratory conditions in non-clinical drinking groups. However, by applying a two-dimensional measurement of alcohol craving prior to assessing decision-making, some support has been evidenced in the present study to suggest that the traditionally neglected avoidance inclination plays a potentially important role in predicting subsequent risky decision-making behaviour.

The negative relationship between the IGT and the BAS, observed here in low risk drinkers, is consistent with existing reports that elevated reward sensitivity is associated with poorer IGT performance (Franken & Muris, 2005; Suhr & Tsanadis, 2007; van Honk, Hermans, Putman, Montagne, & Schutter, 2002). However there were no significant differences in reward sensitivity between the groups, nor did it correlate with approach or the BART. Interestingly, increased avoidance was associated with lower reward sensitivity following alcohol cue exposure, suggesting that avoidance plays a critical role in responding to reward. There was also a gender difference in risky
performance on the BART, which is in line with findings by Lighthall et al. (2009), where inducing stress led to riskier performance in males but not females. Very few studies report whether there are gender differences in BART performance, but those that do largely report no difference (Acheson & de Wit, 2008; Bishara et al., 2009; Lejuez et al., 2007; Reynolds, Richards, & de Wit, 2006), although some have shown limited evidence that males are riskier (e.g., Pleskac et al., 2008).

**Theoretical and Practical Implications**

While both tasks were thought to capture some aspect of approach and avoidance behaviour, the IGT failed to demonstrate a relationship with either dimension of craving at any time point. Furthermore the two tasks were not correlated with each other, suggesting that they measure different decision-making processes. This is consistent with others that have found the two to be uncorrelated (Aklin, Lejuez, Zvolensky, Kahler, & Gwadz, 2005; Bishara et al., 2009; Lejuez, Aklin, Zvolensky, & Pedulla, 2003b). This is despite some authors arguing that these two tasks are similar in that they share a requirement for sequential and repeated decisions for money which both involve initial uncertainty about inherent risks (Bishara et al., 2009). An investigation by Bishara et al. (2009) found that both tasks tap loss aversion and decision-consistency, but not the same learning process. This was established based on a uniformly coloured balloon version unlike the one implemented in the current study. Bishara et al. (2009) suggested that the BART might be more sensitive than the IGT to drug and alcohol use because in some studies, relative to IGT performance, BART performance has been more strongly associated with smoking in undergraduate students and drug use in adolescents (Aklin et al., 2005; Lejuez et al., 2003b). This appears to have been further supported in the present study with the relationship between risk taking on the BART, but not on the IGT, being extended to alcohol craving which is a key characteristic of substance use.
From a theoretical standpoint, the primary purpose of the IGT was to provide evidence for the Somatic Marker Hypothesis (SMH, Bechara, Damasio, & Damasio, 2000). The Somatic Marker Model (see Verdejo-García & Bechara, 2009), provides a 'systems level' neuroanatomical and cognitive framework for decision-making (Bechara, Damasio, et al., 2000). ‘Somatic’ refers to the collection of brain and body responses which indicate affective and emotional states both consciously and unconsciously. The basic premise is that decision-making is guided by emotion; in particular, the neural substrates which are involved in the regulation of homeostasis and emotion. Evidence of this has been provided by the presence of a skin conductance response (SCR) in healthy adults prior to risky choices in the IGT, indicating an implicit emotional anticipation of the outcome (Bechara, Tranel, Damasio, & Damasio, 1996). The SCR is considered to be indicator of the current somatic state (a somatic marker) and has been found to be absent in both prefrontally impaired patients and long term drug users (Bechara, 2003; Bechara & Damasio, 2002; Bechara, Dolan, & Hindes, 2002). This suggests that the neural circuitry involved in emotional signalling and inhibiting risky behaviour (reflective processing) is impaired in these individuals. Bechara (2004) suggested that neurologically impaired individuals who perform poorly on the IGT can no longer process emotional information normally. Since alcohol craving is known to elicit physiological responses (Kaplan et al., 1985; Monti, 1987; Staiger & White, 1991), and is thought to exert a load on executive and affective resources then it may also play a role in decision-making deficits in substance users.

The lack of an association between the IGT and craving, to some extent, weakens the relevance of the SMH to the current investigation, which assumes a link between emotional processing and decision-making. It is important to note, however, that the SMH was developed to explain decision-making deficits in clinically impaired individuals who have either undergone prefrontal damage or have been exposed to
ongoing substance abuse, and therefore it may have limited application in the context of social student drinkers. The BART, on the other hand, appears to capture a dimension of decision-making that is more specific to the experience of craving and its impact on subsequent behaviour. This is possibly because the BART more closely approximates the behavioural nature of approaching and avoiding alcohol, since there are only two opposing response options; pump (approach) or collect (avoid). By comparison, the IGT involves a more complex process of balancing four response options, none of which are consistently associated with behavioural approach or avoidance. This is because high risk decks initially offer high payouts with punishment increasing over time, whereby the adaptable course of action is to switch to the lower risk decks. This is partly why the task has been criticized for tapping into deficits of reversal learning, rather than simply decision-making (Dunn, Dalgleish, & Lawrence, 2006). In terms of simulating behavioural inclinations consistent with approach and avoidance of alcohol, the BART may offer the more congruent behavioural options, particularly with respect to avoidance, as indicated by the significant contribution this dimension makes to task performance in the regression analysis.

While there was an attempt in the current study to align the tasks more closely by incorporating a learning component into the BART, the results indicate that decision-making on the IGT is not related to approach or avoidance of alcohol. However, it has been shown that the IGT has four distinct learning phases (Bechara, Damasio, Tranel, & Damasio, 1997). By analysing each of these phases separately, the relationship between the IGT and approach and avoidance can be further explored. These phases are as follows:

a) Pre-punishment (sampling of the decks)
b) Pre-hunch (encounter punishments but still not grasping task)
c) Hunch (begin to realise the nature of the task but not sure)
d) Conceptual (know the contingencies well)

Interestingly, 30% of controls have been reported to not reach the fourth stage explicitly (Bechara et al., 1997). In impaired individuals, two courses of compromised performance are typically observed, specifically, those who are simply unaware of the task contingencies at the later stages (myopia for the future), usually exhibited by those with prefrontal cortex damage; and those who learn the contingencies but choose to disregard them, which is more typically observed in substance users (Bechara et al., 2001). The latter type of performance deficit reflects the nature of substance abuse, where the risks and consequences are often well understood but the individual continues to engage with the substance at harmful levels. In an attempt to capture a phase of maladaptive decision-making more similar to that experienced by substance users (an understanding of the contingencies), some studies have chosen to analyse only the last two phases of the IGT (40 selections) where the learning phase has largely taken place and uncertainty is reduced (Buelow, 2009; Ko et al., 2010). In the current study, analysis of the last 40 selections still did not show any relationship with craving or the BART, nor was there a significance difference between risk groups on performance. This suggests that the IGT does not offer any utility in the context of evaluating the impact of motivational craving states on decision-making behaviour. Alternatively it may not be sensitive enough to detect any performance variations in a non-clinical sample.

Limitations and Future Direction

This was the first study to directly explore how two separable dimensions of alcohol craving are related to subsequent decision-making performance. In light of the current findings, several limitations and potential extensions have been considered.

Firstly, similar to Jones et al. (2013), the current study used a social drinking student sample which was defined in terms of their self-reported quantity and frequency
of consumption. This is in contrast to Papachristou et al. (2012) who used the Alcohol Use Disorders Identification Test (AUDIT). The AUDIT takes into account the broader characteristics of risky alcohol use, such as the extent to which it leads to harmful behaviour or dependence. To address this limitation in Study 4 (Chapter 5), and consistent with Papachristou et al. (2012), risk status was determined based on the Alcohol Use Disorders Identification Test (AUDIT; Bohn et al., 1995), which does take into account the broader characteristics of risky alcohol use such as the extent to which it leads to harmful behaviour or dependence. Importantly, groups defined by criteria that are partially derived from risky decisions would be considered more likely to show individual differences on tasks of decision-making, than those who were selected simply based on quantity and frequency of consumption.

Secondly, in the present study there was no control group where participants were exposed to a similar craving induction procedure but with non-alcoholic beverage cues. It is unclear if performance on decision-making tasks would be different in a condition where no alcohol cues were presented. This is consistent with the methodology used by Jones et al. (2013), although no differences were found between alcohol and non-alcohol presentation conditions on a disinhibition task. However, it has already been established that the craving effect may have been subject to interference due to lengthy assessments in the Jones et al. study. To further explore the effects of craving on decision-making, one needs to examine performance following exposure to non-alcoholic beverage cues compared to a condition exposed to alcoholic ones. Therefore in Study 4, a comparison condition was included that matched the existing craving induction procedure, but with non-alcoholic beverages substituted for alcoholic ones.

Thirdly, following correction for multiple associations, some strong effect sizes could only be interpreted as non-significant correlations in the present study, which
could be attributed to a combination of a small sample size and the weaker effects typically expected in social drinkers (Jones et al., 2013). While the neural circuitry of largely social student drinkers has been shown to be related to prefrontal dysfunction (Scaife & Duka, 2009), the effect of alcohol cue exposure on simulated decision-making would likely be smaller than in long term users who suffer from abuse or dependence. However, it is possible that the task itself may have limited capacity for detecting a link between alcohol craving and decision-making. Therefore, a task could be developed which increases the salience of decision-making by making it more congruent with alcohol-related outcomes. This could strengthen the observed relationship between risk taking and alcohol craving, even in a social drinking sample. As such, in Study 4, the BART has been reconceptualised so that the stimuli in the task represents simulated access to alcohol. The IGT was not included because it failed to demonstrate even marginal relationships with any of the craving measures in the present study. The BART in its original form possesses fairly arbitrary stimuli (a balloon), which is not necessarily relevant to everyday decisions but simply serves as a convenient proxy. By presenting alcoholic stimuli whilst maintaining the same underlying risk and payoff structure, it would more closely evaluate the processes involved in alcohol orientated decision-making. Developing this variant of the task may be useful to researchers and practitioners in understanding the process of perpetual alcohol seeking in the face of negative consequences, using a laboratory simulation.

Lastly, it is important to determine that such a task would have an association with actual alcohol consumption to support its ecological validity. Therefore, in Study 4, an alcohol consumption task will be administered following cue exposure. This aimed to explore the critical link in addiction between maladaptive decision-making and actual alcohol consumption.
In summary, the present study has offered an important contribution to the literature by revealing that avoidance of alcohol plays a potentially critical role in subsequent risk taking behaviour. This, in conjunction with the findings from Studies 1 and 2, strongly suggests that avoidance should be measured alongside approach inclinations in future, so that the relationship between alcohol use and subsequent behaviour can be better understood. Furthermore, decision-making as measured by the BART (but not the IGT) corresponds to approach and avoidance inclinations, which may have useful applications in the future for assessing the influence of craving on decision-making. This has particular relevance to decisions which involve options analogous to approaching and avoiding reward.
CHAPTER 5 (STUDY 4):

The Development of the Drinking Analogue Risk Task (DART): A Novel Task for Evaluating Alcohol-Related Decision-Making Following Cue Exposure
De Wit (2009) argues that momentary increases in state impulsivity pose a threat for heightened drug use. Furthermore, the effect of repeated drug use on reward circuits in the brain (i.e., neurosensitization) facilitates a cycle of continued maladaptive alcohol use (Robinson & Berridge, 2000, 2003). Alcohol craving is one such state that may increase momentary impulsivity, thus facilitating maladaptive consumption via impaired decision-making. As indicated by the findings of Studies 1, 2, and 3, the conceptualization of alcohol craving as a relative balance, composed of approach and avoidance inclinations, has utility in explaining the complex motivational states that play a role in subsequent consumption and decision-making behaviour. In particular, the simultaneous measurement of both approach and avoidance offers an important improvement in characterising patterns of alcohol inclinations in high and low risk drinkers, as well as between those exposed to alcohol versus control stimuli. The current study extends on previous chapters in the following ways. Firstly, a modified version of the Balloon Analogue Risk Task (BART) was developed to represent simulated access to alcohol in order to more closely measure maladaptive alcohol-related decision-making. Secondly, the relationship between alcohol-related decision-making (as measured by the modified BART) and alcohol consumption was examined as an indication of the ecological validity of the modified BART. Finally, and consistent with Study 2, it was necessary to explore the possibility of group differences in risk taking performance between high and low risk drinkers and, as an important extension, the potential differences in risk-taking performance between those exposed to alcohol and non-alcohol cues on the new task.

**Alcohol and Decision-Making**

Evidence suggests that alcohol exposure has an impact on disinhibition (e.g., Gauggel et al., 2010; Noël et al., 2007) and attentional biases (e.g., Field et al., 2007; Weafer & Fillmore, 2008), and that the alcohol craving response is related to
impulsivity (Papachristou et al., 2012). Furthermore, Study 3 found that approach inclinations were associated with riskier performance on a laboratory task that assesses general behavioural risk, and avoidance inclinations were associated with less risky performance. There is also evidence that a history of alcohol use and craving may influence performance on laboratory measures that have been modified to assess alcohol-related decision-making. On one such measure, The Delayed Discounting Task (DDT; Kirby, Petry, & Bickel, 1999), task performance varied as a function of alcohol craving, and individual differences in alcohol use (e.g., MacKillop et al., 2010b; Vuchinich & Simpson, 1998). Typically, the DDT is administered as a questionnaire which involves selecting a preference for an immediate or delayed hypothetical monetary value, with the magnitude of the monetary value and delay differing across questions. From a sequence of preferences it can be determined how quickly rewards lose their value over time for a given individual. For instance, more frequently indicating a preference for immediate smaller rewards would suggest a higher discounting rate whereby rewards lose their value more quickly. Evidence suggests that there is greater temporal discounting of monetary rewards in both heavy and problem drinkers, than in light social drinkers (Vuchinich & Simpson, 1998). Furthermore, alcohol craving has been found to be positively correlated with the delayed discounting of hypothetical monetary values in heavy drinkers (MacKillop et al., 2010b). This suggests that, for heavy drinkers, the experience of increased state craving decreases the value of hypothetical rewards more quickly over time.

Importantly, the DDT has been modified on a number of occasions to refer to alcohol rewards instead of money, and some variations have directly compared preferences for hypothetical alcohol rewards or money. Discounting rates for alcohol rewards have been found to be higher in active alcoholics compared to abstinent controls, and alcohol rewards are discounted higher than monetary ones, even in
controls (Petry, 2001). In an early craving manipulation, Chutuape, Mitchell, and de Witt (1993) implemented a similar task to the DDT following a priming dose of ethanol. The task was modified to measure preferences between alcoholic beverages and money, with participants opting for the former more often. Field et al. (2007) examined the discounting of alcohol and monetary rewards using separate versions of the DDT for each reward type. They found that heavy drinking college students exhibited increased discounting of both monetary and alcohol rewards compared to light drinkers, and that the magnitude of difference was much larger for alcohol rewards. While increased alcohol discounting was associated with larger attentional bias for alcohol, craving was only associated with attentional bias and not discounting. Studies have shown that, using a traditional multi-choice questionnaire form of the DDT, exposure to alcohol does influence responses to alcohol-related rewards. Consistent with the neurosensitization account of addiction, this is evidence that a history of alcohol use appears to heighten the salience of alcohol-related rewards. This suggests that performance on behavioural measures modified to simulate alcohol rewards may be influenced by a craving for alcohol.

MacKillop and Murphy (2007) exposed 35 heavy beer drinkers to either neutral or alcohol related craving cues, followed by a behavioural task with a similar premise to the DDT, but modified to compare actual sips of alcohol to real monetary rewards. They found that there was a significant increase in craving in response to the induction procedure, but not an increase in the value of alcohol on the DDT. However, when both neutral and alcoholic experimental conditions were collapsed, as a means to increase the power of the analysis in the small sample, it was revealed that craving was significantly associated with the relative value of alcohol on the DDT. The version of the task used by MacKillop and Murphy (2007) was unique because it was not administered as a questionnaire, which is much more common (e.g., Kirby et al., 1999). Instead, actual
alcohol consumption rewards were made available and the task was only 90 seconds long due to the transient nature of craving states (Staiger & White, 1991). The behavioural version of the task used by MacKillop and Murphy (2007) is consistent with earlier studies investigating discounting using cigarette puffs (Madden & Bickel, 1999; Perkins, Epstein, Grobe, & Fonte, 1994). Similar behavioural procedures have been implemented comparing a variety of substances to money with findings consistently showing increased discounting in substance users (Giordano et al., 2002; S. H. Mitchell, 2004; Sayette, Martin, Wertz, Shiffman, & Perrott, 2001). MacKillop et al. (2010b) argued that the findings to date are further evidence that decision-making biases toward immediate rewards, at the expense of future benefits, are consistent with the theorized loss of control that underlies alcohol abuse or dependence (Ainslie, 2001; Vuchinich & Heather, 2003).

Developing a Behavioural Alcohol-Based Decision Assessment

As it is often costly and unethical to administer real substances in decision-making assessment, hypothetical behavioural tasks need to be developed that provide ecological validity for exploring the link between craving and maladaptive alcohol use. Unfortunately, the typical administration of the DDT is, arguably, not behavioural due to the nature of its multi-choice format that refers to rewards in a distant and hypothetical prospective time period (Kirby et al., 1999). Essentially, the rewards are not experienced in real time or in the face of potential loss. This is why the DDT is limited as a “risk” task, because it has no schedule of punishment or loss to reflect the harmful consequences that are typically encountered when pursuing real life reward (e.g., unprotected sex) (MacPherson, Magidson, Reynolds, Kahler, & Lejuez, 2010). Furthermore, there is no sense of accumulation or necessity to learn from each decision on the DDT as there is on the BART. It is because of these limitations, and the findings reported in Study 3, that the BART is considered to be a more appropriate decision-
making assessment for investigating the link between alcohol craving and subsequent risky alcohol-related decisions. Importantly, a study including the BART and the DDT, showed that only performance on the BART was able to predict variations in alcohol consumption and alcohol problems (Fernie, Cole, Goudie, & Field, 2010). Similarly, findings by Weafer, Milich, and Fillmore (2011) showed that BART performance predicted weekly alcohol consumption. A recent investigation by Rose, Jones, Clarke, and Christiansen (2014) found that the ingestion of alcohol prior to the BART resulted in riskier performance than those who were administered a placebo and risk taking performance on the BART mediated approach based craving (Rose et al., 2014). To further explore the important link between craving and maladaptive decision-making in addiction, the BART has been modified in the present study to better align it with risk-orientated decisions specific to alcohol.

The premise of simulating risk taking in the laboratory is to capture aspects of ‘real-world’ decision-making. ‘Real-world’ scenarios involve complex sequences of behavioural patterns which are experienced in the process of receiving reward or punishment (Lowe & Ziemke, 2010). When engaging in a decision-making process, the risk of reward or punishment exist simultaneously for each decision; some accumulation often takes places (small losses and gains contribute to an overall net position); and, importantly, there is some opportunity to learn, which offers the prospect of improving future decisions. Decision-making tasks afford participants time to deliberate over each decision. This allows them to weigh up the reward and punishment associated with each response option, which is reflective of real-world decision-making processes. For example, maladaptive alcohol use often requires some planning and preparation, such as driving to the bottle shop or withdrawing cash from an ATM before going to the pub. Such features of decision-making are largely absent in disinhibition tasks and the DDT, but are critical for alcohol use behaviour because they help characterize the progression
to dependency through a series of smaller decisions that, over time, lead to a
dysfunctional state. To achieve this state, a drinker must engage in multiple drinking
episodes while the consequences of these (hangover, injury etc.) are often disregarded
for the purpose of justifying further engagement with alcohol. Therefore it is important
to develop tasks that more closely reflect this process because ongoing risky drinking
patterns are not simply a case of poor disinhibition or temporal preferences for reward.
Instead, a more complex process of evaluating reward against possible punishment
takes place, which involves risk. Importantly, this evaluation process can be influenced
by motivational states that are characterized by a balance between approach and
avoidance inclinations. The aim of the present study was to increase the conceptual
relevance of the BART to the real-world decisions that characterize maladaptive alcohol
use, so that the association between motivational craving states on decision-making
processes can be more easily captured.

Traditional forms of behavioural risk assessment such as the BART employ
arbitrary stimuli to simulate a risky context in which to earn and lose hypothetical
money. In the case of the BART, this involves the presentation of a balloon which can
be pumped up in order to earn money. However, the balloon may explode on any given
pump in which case the cumulative earnings for that balloon are lost, unless they are
cashed in prior to explosion (Lejuez et al., 2002). In Chapter 4, the BART and the Iowa
Gambling Task (IGT) were both used to investigate the relationship between alcohol
craving and subsequent decision-making. The BART showed some promising
associations with approach and avoidance, suggesting it may have utility for measuring
the influence of craving on risk propensity. By contrast, the IGT did not demonstrate
any associations to suggest that it is linked to these motivational dimensions. As such,
behavioural assessment of risk in the current study only used an adapted version of the
BART, labelled the Drinking Analogue Risk Task (DART), which has been modified to
reflect alcohol stimuli (i.e., a glass of beer) rather than a balloon. While gambling with cards and pumping a balloon serve as a convenient proxy for general risk, neither specifically reflect the process encountered by drinkers when they are presented with an opportunity to engage with their favourite drink. As a solution, the introduction of alcohol stimuli into the BART brings the decision-making assessment in line with risks that are commonly encountered by alcohol users—specifically, the risk of excessively engaging with alcohol.

The Present Study

To date, the BART has not yet undergone a contextual modification to assess substance related behaviours. However, applying such a contextual modification is consistent with studies that have used similar principles to assess the effect of alcohol stimuli on a variety of behavioural and cognitive responses. For instance, alcoholic words (Noël et al., 2007) and pictures (Rose & Duka, 2008) have been substituted into Go/No-go and Stoop (Field et al., 2007) paradigms to assess disinhibition and attentional bias in alcohol exposure studies. It is anticipated that by making task stimuli more congruent with risky alcohol consumption, performance differences might be more readily detected between high and low risk drinking groups and those exposed to either alcohol or control cues.

As in Studies 1, 2, and 3, Study 4 will explore alcohol craving as a function of approach and avoidance dimensions to determine how these motivational inclinations are related to alcohol risk-seeking. Unlike in Study 2, where consumption during the taste test following cue exposure was a dependant variable, the taste test in the present study was considered the final component of the cue exposure. That is, it acts to reinforce and maintain the craving induction in those who were primed to consume beer. This was substantiated by the finding reported in Study 2 that those in the alcohol
condition drank more beer as a proportion of total fluid consumed than those in the non-alcohol condition. Therefore, those primed to consume alcohol, self-administered a higher proportion of beer directly prior to the decision-making task, strengthening their alcohol inclinations compared to the non-alcohol condition.

The aims and predictions of the current study were as follows:

The first aim was to establish that beer taste test consumption is associated with performance on the DART as an initial validation of the task. The second aim was to examine the relationship between approach and avoidance inclinations toward alcohol and risk taking performance on the DART, as was done with the BART in Study 3. The final aim was to test for specific differences in performance on the DART between low and high risk drinkers and alcohol and non-alcohol cue exposure conditions.

In line with these aims, the following predictions were made:

(1) As a measure of the ecological validity of the DART, increased alcohol consumption in the taste test would be associated with riskier performance. This is because increased sipping of the actual beer glass in the taste test would be directly related to increased ‘sipping’ of simulated beer glass and increasing the likelihood of the glass shattering.

(2) Consistent with the broad application of the Ambivalence Model and Study 3, it was hypothesized that when high and low risk drinkers are induced into a craving state, (a) approach ratings toward alcohol would be positively associated with approach (riskier) behaviour on the DART. It was also hypothesized that (b) avoidance ratings toward alcohol would be negatively associated with approach behaviour on the DART.
(3) Consistent with the neurosensitization account and as was predicted in Chapter 4, exposure to alcohol cues would presumably lead to a more intense craving effect on the cognitive and neuroanatomical resources in the high risk group as compared to the low risk group in the alcohol condition. Similarly, these processes are thought to affect those in the alcohol condition more strongly than those in the non-alcohol condition. Also, given the evidence that alcohol rewards are discounted at a higher rate than monetary ones in high risk drinkers (Field et al., 2007; Petry, 2001) and that BART performance is poorer following alcohol ingestion (Rose et al., 2014), it was anticipated that there would be group performance differences on the DART (a) between low and high risk drinkers, and (b) between those exposed to alcohol and non-alcohol cues. This would be observed as riskier performance in the high risk group compared to the low risk group and riskier performance in those exposed to alcohol cues compared to those exposed to non-alcohol cues. Furthermore, because those in the alcohol condition and high risk drinkers exhibited a stronger craving response than the non-alcohol condition and low risk drinkers, respectively (see Chapter 3, pages 55-61), a (c) Group x Condition interaction was also predicted.

Method

Participants

The same sample in Study 3 (Chapter 4) was used to collect the decision-making and beer consumption data. Refer to page 49 for participant characteristics.

Materials

As per Study 2 and 3, the AUDIT, BIS/BAS, craving items (approach and avoidance inclinations towards alcohol), and the AAAQ were included in the present
study (see pages 25, 50, & 89). As described in Study 2, the demographic questionnaire included an additional question to ascertain the participant’s non-alcoholic beverage preference (soft drink or juice).

**Drinking Analogue Risk Task (DART).** The BART was modified by substituting the balloon with a full glass of beer, which instead of being pumped can be ‘sipped’ in order to reduce the volume marginally on each selection and earn a hypothetical five cents. Instead of the risk of explosion, the glass was capable of shattering on any given sip. The ‘shatter’ schedule used the same randomization as the explosion schedule in Study 3, and was kept consistent for all participants. The outcome measures analysed in the present study were the average number of sips and number of shatters. Consistent with the original task and the version used in Study 3, coloured risk indicators were included in the task. This was achieved in the DART by varying the colour of the coaster below the beer glass (instead of the balloon) depending on its level of risk. In the version used in Study 3, the colours, red, blue, and green were used to indicate a mean explosion point of 16, 32, and 64 pumps, respectively. The DART used these same colours matched to the same mean explosion points. The DART was programmed using Inquisit 3 (Millisecond Software). An illustration of the modification is shown in Figure 1.

![Figure 1](image_url)

*Figure 1. Original and modified versions of the Balloon Analogue Risk Task.*
The Alcohol Craving Induction. The alcohol craving induction materials remained the same as in Study 3, whereby the materials were simplified so that only the beer imagery was used in the alcohol condition to make it congruent with what was offered in the taste test and the DART. A non-alcohol condition was also included whereby two additional still and video montages were available which matched the beer imagery but presented soft drink or juice depending on the participant’s preference. Consistent with Studies 1, 2, and 3, there was also an A3-sized poster visible which showed the relevant beverage, and appropriate beverage cartons were stacked next to the fridge.

The Taste Test. The description of the taste test can be found in Study 2 (see Chapter 3, page 51).

Procedure

The screening and recruitment procedure was detailed in Study 2 (see Chapter 3). The laboratory procedure was identical to Study 2 except that after the Time 3 craving assessment, participants also completed the DART. See Figure 2 for the experimental timeline. Participants were informed they were eligible for an AU$5 cash reward should they perform ‘well enough’ on the DART. The purpose of this was to increase the salience of the monetary values in the task and increase task engagement, consistent with others (e.g., Lee et al., 2009) At the end of the session, all participants were awarded the cash reward, regardless of performance. The session took between 45 to 60 minutes.
Results

Craving Manipulation

As detailed in Chapter 3, the craving induction was demonstrated to be successful, in that those in the alcohol condition experienced stronger approach and avoidance response than those in the non-alcohol condition, please refer to pages 53-61. These analyses have been extended here to show that this craving effect was maintained throughout the DART, with increases in approach, $t(39) = -2.83, p < .01, d = -.47$, and decreases in avoidance, $t(39) = 2.92, p < .05, d = .35$, still significant between baseline assessment (Time 1) and after the administration of the DART (Time 4).

Decision-Making

Prediction (1) was addressed by conducting Pearson correlations between beer consumption in the taste test and average sips and shatters on the DART across both conditions and groups. There were significant positive correlations between beer consumed (mL) and both average sips ($r = .23, p < .05$), and shatters ($r = .27, p < .05$), supporting the ecological validity of the task for capturing simulated alcohol consumption.

The hypothesized positive association between approach and DART risk taking (2a), and negative association between avoidance and DART risk taking (2b) was
addressed by conducting Pearson correlations between the baseline (Time 1) and post-cue exposure (Time 3) craving measurements and the DART outcome measures (see Table 1). Consistent with previous chapters, the association between the relative balance (approach – avoid), where a positive score indicates more dominant approach inclinations and a negative score indicates more dominant avoidance inclinations, and the DART, have also been reported in Table 1.
Table 1

*Pearson Correlations for Low and High Risk Drinkers in Both Exposure Condition at Pre- and Post-Craving Intervals between the DART and Craving*

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<th>Time 1</th>
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<th>Time 3</th>
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<th>Relative Balance</th>
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<td>Sips</td>
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<td>Shatters</td>
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<td>Sips</td>
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<td>Shatters</td>
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<tr>
<td><strong>Low Risk</strong></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Sips</td>
<td>.10</td>
<td>-.23</td>
<td>-.02</td>
<td>-.09</td>
<td>.24</td>
<td>.05</td>
<td></td>
</tr>
<tr>
<td>Shatters</td>
<td>.09</td>
<td>-.20</td>
<td>-.07</td>
<td>.04</td>
<td>.20</td>
<td>-.06</td>
<td></td>
</tr>
<tr>
<td><strong>High Risk</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Sips</td>
<td>.07</td>
<td>-.01</td>
<td>-.04</td>
<td>-.03</td>
<td>.05</td>
<td>-.01</td>
<td></td>
</tr>
<tr>
<td>Shatters</td>
<td>.09</td>
<td>-.19</td>
<td>.01</td>
<td>-.11</td>
<td>.15</td>
<td>.06</td>
<td></td>
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</tbody>
</table>

*Note.* Correlation coefficients that reached significance (*p* < .05) are displayed in bold, no correlations were significant following a sequential Bonferroni adjustment for each group and condition.
As can be seen in Table 1, there are strong correlations between the average sips, shatters and approach prior to the DART (T3) in high risk drinkers in the alcohol condition. Fisher’s $Z$ comparisons confirm that the correlations between sips, $Z = 1.96, p < .05$, but not shatters, $Z = 1.42, p = .15$, are significantly different to those found in high risk drinkers in the non-alcoholic condition. Furthermore, there are strong correlations between average sips and the relative balance of craving at Time 3 in high risk drinkers in the alcohol condition. Importantly, the effect sizes of these correlations are at least double the size of the correlations at Time 1, suggesting that the craving induction had an impact on the association between craving and decision-making. The pattern of findings also showed that for those not primed to consume alcohol; there was no relationship between craving and decision-making. As there were was only an uncorrected significant relationship found between the DART and approach in high risk drinkers in the alcohol condition, prediction (2a) was partially supported. The lack of an association between the DART and avoidance at all meant prediction (2b) was not supported.

It should be noted that considering correction for the number of correlations, strict levels of significance were not achieved in all cases so these interpretations can only be tentative. Without correction, a number of these correlations could reach significance due to chance alone.

Because the effect sizes of the Time 3 avoidance correlations with average sips and shatters were not small in high risk drinkers in the alcohol condition, two linear regressions were performed as a follow up to determine the relative contribution of approach and avoidance to sips and shatters. Firstly, average sips were regressed onto Time 3 approach and Time 3 avoidance. Secondly, shatters were regressed onto Time 3 approach and Time 3 avoidance. The analysis has been reported in Table 2.
Table 2

Linear Regression with Average Sips and Shatters Regressed onto Approach and Avoidance

<table>
<thead>
<tr>
<th>Predictor</th>
<th>$b^*$</th>
<th>$\beta$</th>
<th>SE</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average Sips</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T3 Approach</td>
<td>1.44</td>
<td>.52</td>
<td>.59</td>
<td>2.44</td>
<td>.03</td>
</tr>
<tr>
<td>T3 Avoid</td>
<td>-.36</td>
<td>-.12</td>
<td>.64</td>
<td>-.56</td>
<td>.59</td>
</tr>
<tr>
<td><strong>Shatters</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T3 Approach</td>
<td>.98</td>
<td>.45</td>
<td>.50</td>
<td>1.95</td>
<td>.07</td>
</tr>
<tr>
<td>T3 Avoid</td>
<td>-.06</td>
<td>-.03</td>
<td>.55</td>
<td>-.11</td>
<td>.91</td>
</tr>
</tbody>
</table>

* Unstandardized beta weight

Table 2 confirms that only Time 3 approach was a significant predictor of decision-making performance in high risk drinkers who had been primed to consume beer.

To address the predictions that there would be riskier DART performance in those exposed to alcohol cues (3a), in high risk drinkers (3b) and a Group x Condition interaction (3c), two 2 x 2 (Group x Condition) independent ANOVAs were conducted for average sips and shatters respectively. Analysis showed that there was no main effect of group, $F(1, 75) = 2.19, p = .14, \eta^2 = .03$, condition, $F(1, 75) = .36, p = .55, \eta^2_{\text{partial}} = .00$, and no Condition x Group interaction, $F(1, 75) = .03, p = .86, \eta^2_{\text{partial}} = .00$, for average sips. For shatters, there was also no main effect of group, $F(1, 75) = 2.05, p = .16, \eta^2_{\text{partial}} = .03$, condition, $F(1, 75) = 1.37, p = .25, \eta^2 = .02$, or interaction, $F(1, 75) = .15, p = .70, \eta^2_{\text{partial}} = .00$. Therefore predictions (3a), (3b), and (3c) were not
supported. Descriptive statistics for the DART outcome measures across conditions and groups is available in Table 3.

Table 3

*Descriptive Statistics for DART Average Sips and Shatters across both Conditions and Groups*

<table>
<thead>
<tr>
<th></th>
<th>Low Risk Drinkers</th>
<th></th>
<th>High Risk Drinkers</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alcohol</td>
<td>Non-Alcohol</td>
<td>Alcohol</td>
<td>Non-Alcohol</td>
</tr>
<tr>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td></td>
</tr>
<tr>
<td>Average Sips</td>
<td>16.73</td>
<td>4.45</td>
<td>17.67</td>
<td>5.85</td>
</tr>
<tr>
<td>Shatters</td>
<td>9.10</td>
<td>3.18</td>
<td>9.85</td>
<td>5.04</td>
</tr>
</tbody>
</table>

Analyses were also conducted to examine whether there were any group differences in DART performance or relationships with craving on the outcome measures associated with the differing risk level beer glass trials (indicated by the coloured coasters).

There were no significant differences in sips or shatters for any risk level between high and low risk groups. However, those in the non-alcohol condition did exhibit greater sips, \( t(77) = 2.51, p < .05, d = .57 \), and shatters, \( t(77) = 2.03, p < .05, d = .46 \), on the green coaster trials (riskiest) than the alcohol condition. This suggests that subsequent DART behaviour was riskier in those not exposed to alcohol.

In the non-alcohol condition, in low risk drinkers, there were significant negative correlations between green trial sips and Time 1, \( r = -.58, p < .01 \), and Time 2, \( r = -.52, p < .05 \), avoidance and a positive correlation with the Time 1 relative balance score, \( r = .53, p < .05 \). This suggests that avoidance may play a greater role for low risk
drinkers on trials where there is a higher likelihood for punishment when they are not exposed to alcohol. In the alcohol condition, high risk drinkers showed a significant positive correlation between blue trial sips and Time 3 approach, \( r = .62, p < .01 \), and the Time 3 relative balance score, \( r = .54, p < .05 \), which is consistent with the overall pattern of correlations reported earlier.

Lastly, average sips, \( r = .16, p = .17 \), and shatters, \( r = .18, p = .11 \), on the DART were not associated with AUDIT scores.

**Discussion**

A primary aim of the present study was to demonstrate that performance on the DART would correspond to ad libitum beer consumption. A correlational analysis confirmed that prediction (1) was supported, as DART performance was significantly and positively associated with beer consumption. This provides preliminary evidence that the DART possesses some utility capturing propensity for alcohol-related risk behaviour.

In Study 3, approach and avoidance were positively and negatively correlated (respectively) with at least one of the outcome measures of the BART. In the present study, the change in task stimuli was anticipated to increase the strength of these relationships because the decision-making outcomes were congruent with the craving induction stimuli. Consistent with this expectation, and despite smaller group sizes, the correlations between post-craving induction approach and both outcome measures of the DART were stronger than the respective relationships in Study 3, meaning that prediction (2a) was supported. Because no significant relationships were found between avoidance and DART outcome measures, prediction (2b) was not supported. The contribution of approach, but not avoidance, toward risky outcomes on the DART was confirmed with a regression analysis. This is inconsistent with Study 3 where avoidance
showed a significant negative correlation with pumps at baseline in low risk drinkers, and was the only significant predictor in a regression analysis across both risk groups. Furthermore, moderate but non-significant correlations were also found between both BART outcome measures and avoidance in Study 3. While this pattern was not observed in the present study, there was a moderate non-significant correlation between avoidance at Time 3 and sips in high risk drinkers. Potentially with more statistical power, a significant relationship may have been detected.

Inconsistent with predictions (3a), (3b), and (3c) there were no group, condition, or interaction effects on DART performance, suggesting that decision-making performance is not impaired due to alcohol craving in high risk drinkers compared to low risk drinkers, or in those exposed to alcohol cues compared to those who were not. The lack of a difference between risk groups is consistent with Study 3 and shows that despite increasing the incentive relevance of the decision-making task to the craving manipulation, the likelihood of finding performance differences was not enhanced. Given that this hypothesis was not supported, it is likely that any potential effects of neurosensitization are not profound enough to impair decision-making in heavy drinking university students.

**Theoretical and Practical Implications**

The present study found that when the BART was modified to reflect alcohol-relevant stimuli (as the DART), typical outcome measures were not only still related to craving inclinations but, in high risk drinkers, the obtained effect sizes were larger. However, there were no significant associations between avoidance and DART performance, even in low risk drinkers, where associations were detected in Study 3. In previous studies in this thesis, avoidance has shown a potentially important relationship with a key outcome measures that approach did not. However, the present chapter suggests that when the decisions are more directly relevant to alcohol, approach
inclinations become more important for risky behaviour, particularly for high risk drinkers. Despite the lack of a relationship with avoidance, the relative balance of both inclinations was associated with DART performance outcomes in high risk drinkers with almost the same strength as approach alone. This further supports that a craving measure that is weighted by the contribution of avoidance has utility for assessing motivational alcohol craving states. It was also interesting to note that avoidance was significantly negatively correlated with outcome measures on the riskier (green) DART trials in the non-alcoholic condition, suggesting that it may still play an important role for minimising subsequent risky behaviour in the absence of alcohol cues.

Consistent with a study examining nicotine craving and the BART (Buelow, 2009), no group differences in performance were found on the DART following a craving induction. Papachristou et al. (2012), similarly found no difference in inhibition or performance on a monetary reward sensitivity task between high and low risk drinkers. The present findings are inconsistent with evidence that BART performance (average pumps) is significantly riskier in those primed with the ingestion of alcohol compared to a placebo (Rose et al., 2014). However, studies that involve administration of alcohol are also actually examining the neurobiological effects of its ingestion rather than simply the craving response to its cues. While the present study did include the ingestion of beer prior to the DART, it was non-alcoholic and thus, no different to the placebo condition used by Rose et al. (2014). Furthermore, while the participants recruited by Rose et al., (2014) were also university students, but with a lower mean AUDIT score than the present high risk drinking group, it was a substantially larger sample \((N = 142)\) than the present study \((N = 79)\), and would have provided the power necessary to detect a group effect.

Aside from potential power issues, it is not clear why a version of the BART designed to be more salient to alcohol use did not yield even a trend effect toward group
differences or an overall significant association with avoidance, the latter of which was found in Study 3. However, there are some potential considerations that do limit the BART’s utility for assessing risk taking. For instance, it has been frequently evidenced that participants do not pump maximally on the task, which constrains the potential variability of the responses. For example, most versions of the task are consistent with a mean explosion point of 64 pumps and an upper bound maximum of 128 pumps, yet most studies report mean pump ranges around 25 to 45 (e.g., Bornovalova et al., 2009; Hopko et al., 2006; Hunt, Hopko, Lejuez, & Robinson, 2005; Lejuez et al., 2007; Lejuez et al., 2003a; Lejuez et al., 2002). This suggests that most individuals do not perform optimally on the task, since maximum profit would be yielded by pumping close to mean explosion point (Lejuez et al., 2003a). Variations of the task have been developed that, in part, have addressed this issue. For example, several investigations have compared versions of the task that increased trial incentives by offering between one and 25 cents per pump (instead of the typical 5) with findings suggesting that risk taking decreases with increased value of the pumps (Acheson & de Wit, 2008; Bornovalova et al., 2009), which would further restrain the variability of the performance outcomes. An approach has been tested in a version that involved pumping to reduce loss (i.e., participants start out with a fixed deficit value and need to pump to return to even). This version of the task yielded substantially higher pumping rates (i.e., above 50) than the typical version, suggesting that framing the pursuit of reward as a reduction of loss may increase risk taking (Benjamin & Robbins, 2007). The characterisation of this altered behaviour is consistent with current DSM-5 criteria for pathological gambling, whereby individuals ‘chase’ previous losses to get even (American Psychiatric Association, 2013). Given that pumping rates are sensitive to task modification of incentive, it may be of practical importance to further modify the payout contingencies of the DART to improve its utility as measure of simulated risk.
Limitations and Future Direction

This was the first study to modify the conceptual presentation of the BART to directly explore whether opposing dimensions of alcohol craving are related to subsequent decision-making performance. Unfortunately, not all of the hypotheses were supported and in light of this, several limitations and potential extensions have been considered.

Firstly, as discussed previously, power was a likely issue in failing to demonstrate group effects and expected associations. A sample size of 79, split into four groups (Condition x Risk Group) resulted in unique group sizes of around 20, which is much smaller than other similar studies using university samples (e.g., Jones et al., 2013; Rose et al., 2014). Therefore, in Study 5, presented in Chapter 6, a larger sample size will be sought to increase the power of the analyses, thus improving the likelihood of detecting group effects and yielding significant associations between craving and task outcomes.

Secondly, it is possible, that responses on the DART may have suffered from constrained variability due to commonly observed sub-optimal pumping (sipping) behaviour (Lejuez et al., 2003a), particularly given the underpowered sample in the present study. To address this issue, it may be possible to facilitate sipping behaviour by increasing the ongoing incentive. While some studies have shown that higher fixed pump values for a given balloon in the task decreases risk taking (e.g., Bornovalova et al., 2009), it may be possible for future investigations to optimize engagement by variably increasing the pump (or sip) value on each balloon (or glass). Essentially, the longer a participant engages with the same glass, the higher the incentive to continue, rather than cash in. Furthermore, it could be useful to inform participants of average explosion points to reduce the likelihood of premature cashing in, and therefore suboptimal earning strategies.
A further limitation of the DART was that it only presented beer stimuli, which, consistent with a limitation of Study 3, may not have been salient enough for the proportion of the sample (49.4%) who reported themselves as ‘sometimes’ (as opposed to ‘always’ or ‘mostly’) beer drinkers. This highlights the difficulty in finding mostly or exclusive beer drinkers in undergraduate samples who also conform to desired risk criteria. To increase the salience of the stimuli, the DART may need to be equipped to present a variety of beverage types, depending on the participant’s preference, to enhance the relevance of the task to individual drinking preferences and broaden the potential sample. Also related to the suitability of the stimuli presented in the DART, the breaking of the glass may not be considered a relevant consequence of excessive alcohol consumption. In addition, the end of each trial does not conceptually “reset” the simulated alcohol consumed. Future versions of the task may need to account for these conceptual issues. However, it would be challenging to account for a range of possible negative drinking consequences within such an analogue task. The glass breakage served as a convenient and similarly aversive outcome to an exploding balloon.

Finally, the DART failed to demonstrate a relationship with risky drinking history (AUDIT scores), which is inconsistent with a number of studies that support its association with self-reported real-world risk (Fernie et al., 2010; Holmes et al., 2009; Lejuez et al., 2002; Lejuez, Simmons, Aklin, Daughters, & Dvir, 2004). It has already been identified that potential power and composition issues with the present sample may have contributed to diminished statistical effects. However, it was still demonstrated that risky behaviour was related to acute alcohol consumption which provides an important ecological validation of its potential utility. It is possible that additional modifications (as described above) may be helpful to further validate this version of the task by exploring its relationship with real-life risk propensity. However, given that investigations using the BART and then the DART did not support all the
anticipated hypotheses, it suggests that it may be important to explore alternative methods of alcohol risk assessment. While laboratory assessments for dispositional risk taking behaviour such as the BART and the DART are a convenient proxy for real-world risk-taking behaviour, it is important to acknowledge that they are not the only means to estimate risk propensity. For instance, to generate more accurate estimates of real-world risk-taking behaviour as a result of exposure to alcohol, there may be suitable utility in a self-report scale that measures perception for risk taking during future alcohol use episodes. Therefore, this thesis will undertake a new and final phase of risk assessment evaluation by attempting to validate a self-report measure in Study 5 (Chapter 6) that is designed to assess hypothetical alcohol-related risk.

In summary, the present study has taken some preliminary steps in evaluating a novel task for assessing simulated alcohol consumption. However, some hypotheses were not supported, potentially due to challenges associated with the methodology and sampling. To further explore the relationship between alcohol use and risky behaviour, alternative forms of alcohol risk assessment will be pursued that are methodologically less challenging to administer and more directly relevant to real-world alcohol-related risk taking. By acknowledging the limitations of the measures used in this thesis thus far and identifying a novel direction for alcohol-related risk assessment in Chapter 6, the relationship between maladaptive alcohol use and risky behaviour can be further explored.
CHAPTER 6 (STUDY 5):

Development of a Novel Hypothetical Scenario-Based Alcohol Risk Measure
Previous chapters of this thesis have demonstrated the challenges inherent in estimating the role that exposure to alcohol cues plays in subsequent risky behaviour, using typical lab-based behavioural measures. Modification of existing behavioural measures to capture risk taking specific to alcohol consumption showed some promise in evaluating this relationship, but results regarding the role of approach and avoidance dimensions of craving in risky decision-making were inconsistent. Specifically, Study 3 showed that baseline levels of both approach and avoidance were associated with risky decision making. Interestingly, in Study 4, approach, but not avoidance, was associated with risky decision-making, but only following cue exposure. Several sampling and methodological considerations were identified as potential factors in explaining these inconsistent effects.

Importantly, the behavioural measures utilized in this thesis thus far represent only one broad category of risk assessment, which can be supplemented by other potentially useful and easier to administer alternatives. In particular, there are presently a limited number of self-report measures available that specifically assesses alcohol-related risky behaviours. While many studies have collected self-reported historical risky behaviour, there has been no well-validated measure available to assess a current or prospective (i.e., hypothetical) disposition to engage in risky behaviour specifically as result of drinking.

The purpose of the present chapter was to develop a prospective self-report measure to assess alcohol-related risk taking, to complement the behavioural measures already explored in this thesis. In order to validate the new measure, a large sample data collection was required, which was not suitable for a state-based craving manipulation and assessment. Instead, the focus of this chapter was on evaluating whether the perception of alcohol consumption influences future risk taking behaviour, while also collecting self-reported trait level craving assessments of approach and avoidance of
alcohol. The newly validated assessment tool might also be useful for evaluating the self-perceived influence that alcohol plays in decision-making behaviour across several risk domains.

**Characterising Risk**

Risk propensity refers to the inclination to behave in a manner that exposes an individual to harm or loss (Leigh, 1999). This harm or loss is typically offset by the opportunity to receive some form of reward (Lejuez et al., 2002). Such rewards provide the motivation to warrant exposure to harm or loss, with the perceived incentive of the reward being dependent on the individual (e.g., alcoholic rewards are worth more to those who drink than to those who do not drink). Risk propensity has been viewed as a personality trait (e.g., Bromiley & Curley, 1992; Knowles, Cutter, Walsh, & Casey, 1973), but also as an unstable trait variable across several domains (e.g., health, finance, social, etc.) (Harrison, Young, Butow, Salkeld, & Solomon, 2005; D. N. Jackson, Larry, & J., 1972; Weber, Blais, & Betz, 2002) and can be dependent on how the risk is framed (i.e., reducing loss versus increasing a gain) (Benjamin & Robbins, 2007; Kahneman & Tversky, 1979). Importantly, risky behaviour forms part of the criteria for the classification of a number of psychopathological disorders throughout the DSM-5 (American Psychiatric Association, 2013), such as ADHD, pathological gambling, personality disorders, and substance use disorders, including alcohol use.

Aside from its clinical importance, a wide body of literature suggests that risk taking can be moderated by a variety of factors, such as mood (Cyders et al., 2010; Deckman & DeWall, 2011), gender (Arnett, 1996; Byrnes, Miller, & Schafer, 1999; Duangpatra, Bradley, & Glendon, 2009; Jesser, Turbin, & Costa, 1997), and age (Jessor et al., 1997; Rhodes & Pivik, 2011), with particular prevalence in ‘emerging adult’ populations (late teens to early twenties) (Arnett, 2005; Johnston, O'Malley, Bachman,
& Schulenberg, 2005; H. R. White & Jackson, 2004) compared to younger or older samples (Duangpatra et al., 2009).

The assessment of risk propensity in typically functioning young adults may be particularly important for predicting subsequent psychopathology or adverse future consequences in a wide range of areas (i.e., financial, health, legal). Consistent with the aims of preceding chapters, the present chapter is concerned with the role alcohol plays in risk propensity in non-clinical drinkers. Because risk propensity can be attributed to a variety of factors, it is necessary to develop assessment strategies that estimate the relative contribution that drinking alcohol makes toward risky behaviour. There are presently a number of scales available to evaluate the parameters associated with risky alcohol consumption and behaviour based on historical precedents. However, there is very little available for evaluating the current or future disposition for risky behavioural outcomes that may ensue as a result of alcohol consumption.

**Alcohol and Risky Behaviour**

Given that alcohol is the most commonly used licit drug amongst Australian adolescents (Austalian Institute of Health and Welfare, 2011; V. White & Bariola, 2012), it is crucial that its impact on subsequent behaviour is understood. There is a wide body of evidence suggesting that alcohol use increases risk-taking behaviour. In particular, there are multiple reports that increased sexual risk taking, in the form of unprotected sex and casual partners, follows alcohol use (Hingson, Heeren, Winter, & Wechsler, 2003; Hingson, Heeren, Zakocs, Kopstein, & Wechsler, 2002; Leigh, Temple, & Trocki, 1994; McEwan, McCallum, Bhopal, & Madhok, 1992; Thompson, Kao, & Thomas, 2005). Typically, these data are collected from self-reported recollection or diary entries. However, this information does not always discriminate between drinking and non-drinking risky encounters for a single participant, which may be an important distinction. For example, some studies have shown there is no
difference in condom use for drinking versus non-drinking encounters (J. L. Brown & Vanable, 2007; Desiderato & Crawford, 1995; Temple, 1992). Therefore, any new measure assessing alcohol influenced sexual behaviour should attempt to account for instances where alcohol is not involved. This presents a challenge for laboratory studies because of the sensitive nature of real-word risky behaviours compared to that of the behaviour typically assessed by laboratory-based tasks.

The administration of alcohol in the laboratory has been shown to increase simulated risk taking behaviour, compared to non-alcohol administration (e.g., Abrams, Hopthrow, Hulbert, & Frings, 2006; Sayette et al., 2000). However, behavioural responses to simulated risk (usually in the form of gambling-style options), while a convenient proxy, are fundamentally different to capturing specific risk taking behaviours that are encountered in real life, such as opportunities that expose an individual to health/sexual, legal, financial and social/ethical consequences. Since opportunities to engage in these types of risk cannot be directly assessed in the laboratory, researchers rely on validated self-report measures that can estimate risk propensity across these domains. Because different domains of negative consequences could be associated with different levels of risk propensity for any given individual (i.e. more likely to engage in sexual risk than injurious risk when drinking), it is important to use measures that estimate risk propensity across different contexts.

To inform the development of a suitable measure for the assessment of alcohol-related risky behaviour, the following section reviews the measures available to date which are most relevant to alcohol-related risk assessment, and how the present study seeks to develop a unique approach for assessing alcohol-related risk.
Alcohol-Related Risk Assessment

Typically, the relationship between alcohol and risk taking is estimated through global correlation methods, where measures of historical alcohol use (i.e., quantity and frequency of consumption) (e.g., Modified Daily Drinking Questionnaire (DDQ-M), Dimeff, Baer, Kivlahan, & Marlatt, 1999; Quantity-Frequency Index (QFI), Straus & Bacon, 1953) and risk taking are assessed separately and then correlated to determine the relationship (e.g., Arnett, 1996; Balodis, Potenza, & Olmstead, 2009; Lejuez et al., 2002). To support the fundamental aim of identifying a potentially causative link between alcohol use and risk taking, measurement of the co-occurrence is necessary to improve upon global correlation methods, where it cannot be presumed that they have taken place concurrently.

In order to assess alcohol-related risk behaviours beyond separately assessing consumption and risk measures, a variety of measures currently exist to estimate the prevalence of behaviours directly related to alcohol use. However, these measures typically request a self-reported recollection of past risky alcohol-related activities or consequences of such activities. The traditional focus on historical risk assessment is argued here to be limited for estimating a current or future disposition for risk taking, which is why a novel risk measure needs to be developed which is specifically relevant for prospective circumstances.

Of the measures presently available, some were designed specifically to assess risky behaviour relevant to relapse and motivation for drinking in alcoholic populations and thus are not suitable for measuring alcohol-related risk propensity in non-clinical populations (e.g., Inventory of Drinking Situations, Annis & Graham, 1995; Drinking Context Scale, O'Hare, 1997b; Reasons for Drinking Questionnaire, Zywiak, Connors, Maisto, & Westerberg, 1996). However, some of these measures do distinguish between several domains of risk such as work-related and financial (e.g., Drinking Patterns
Questionnaire, Zitter & McCrady, 1979), which is a useful principle for providing a more comprehensive and specific assessment of alcohol-related consequences. The present study aims to develop a measure that incorporates a similar principle of separating domains of risk but with relevance for a non-clinical population.

For non-clinical groups, several measures have been developed to assess alcohol-related risk taking behaviour, particularly aimed at adolescents. The 27-item Young Adult Alcohol Problems Screening Test (YAAPST, Hurlbut & Sher, 1992) extends on evaluating diagnostic issues of alcohol use (e.g., blackouts) by requesting historical instances of risky behaviour following alcohol use, such as regretful sexual situations and impact on academic performance. A later measure, the 48-item Young Adult Alcohol Consequences Questionnaire (YAACQ, Read, Kahler, Strong, & Colder, 2004; Read, Kahler, Strong, & Colder, 2006) was developed using a subset of items from the YAAPST and the Drinker Inventory of Consequences (DrInC, W. R. Miller, Tonigan, & Longabaugh, 1993) as well as new items to similarly assess consequences of past drinking episodes. Similarly, the College Alcohol Problems Scale (CAPS, Maddock, Laforge, Rossi, & O'Hare, 2001; O'Hare, 1997a) also assesses historical encounters with risk scenarios in drinking contexts across a range of domains. Kahler, Strong, and Read (2005) argued that both the YAAPST and the CAPS lacked adequate risk domains and risk severity and opted to develop a (brief) 24-item version of the (B-)YAACQ, more practical for research purposes. The B-YAACQ items are dichotomously rated (i.e., whether behaviour was present in the last year or not) and has demonstrated acceptable internal consistency, as well as convergent and concurrent validity (Gonzalez, Reynolds, & Skewes, 2011; Kahler et al., 2005; Read et al., 2006).

One of the most well-validated and widely used measures for evaluation of alcohol problems is the AUDIT (Bohn et al., 1995), which is recommended by the World Health Organization and has excellent psychometric properties (Meneses-Gaya,
Zuardi, Loureiro, & Crippa, 2009; Reinert & Allen, 2007). A unique feature of the AUDIT is that it yields a combination of quantity and frequency information, as well as diagnostic-style criteria (i.e., interference of alcohol use with typical functioning) that offers a more thorough classification of misuse. However, the AUDIT only offers minimal reference to risky behaviours as an outcome of drinking (e.g., guilt, injury) and similar to the YAAPST, YAACQ and the CAPS, is based solely on historical precedents.

For use in non-clinical samples, the YAACQ and the AUDIT are more commonly favoured in contemporary research on alcohol risk assessment. However, because both measures target historical risky experiences as a result of alcohol use, they may not accurately reflect a present disposition and cannot estimate risk propensity for circumstances that an individual has not experienced (e.g., the opportunity to engage in unprotected sex may not have yet presented itself). Essentially, an individual may have propensity to engage in a particular behaviour in the future, despite not having engaged in that behaviour previously. Therefore, it is important to have measures that can predict risky behaviour based on current dispositional attributes.

Furthermore, present dispositions may be influenced by historical risky behaviours. For instance, some individuals may have engaged in sexually risky behaviour in the past 12 months, which has led them to adopt a lower risk propensity for future risky sexual encounters. Therefore, the challenge lies in developing a measure that can offer an opportunity to evaluate risk propensity in future circumstances across a range of possible behaviours. Finally, existing measures are limited by their inability to separate the contribution of alcohol from a general disposition toward risky behaviour (e.g., individuals may engage in unprotected sex regardless of whether they have been drinking or not). The development of a measure which presents prospective risk opportunities (i.e., hypothetical scenarios) can address these limitations, because ratings
can be collected with reference to future settings that represent both drinking and non-drinking circumstances. Relevant ratings can then be compared to determine the relative perceived influence that alcohol plays in risk propensity.

In contrast to the literature on alcohol-related risk assessment, self-reported prospective risk assessments have been widely developed in evaluating general behavioural risk. In a review by Harrison et al. (2005), several measures were identified as conforming to this format. For example, the Domain-specific Risk-attitude Scale (DOSPERT, Weber et al., 2002) proposes a range of 40 risky propositions (e.g., having an affair, white water rafting in dangerous waters) across several domains (financial, health/safety, and ethical), which are rated on how likely they would be engaged in. The scale showed good psychometric properties and it also revealed that risk aversion was highly domain specific (i.e., risk taking was not consistent across all domains) (Weber et al., 2002), highlighting the importance of assessing different risky contexts. Similarly the risk situation (RSQ) component of the Risk Propensity Questionnaire (RPQ, Rohrmann, 2002) presents real-life dilemmas covering domains of physical hazards (accident and illness), financial risk and social risk where participants rate the likelihood they would engage in the behaviour (e.g., climbing a dangerous rock face). The scenarios presented in this questionnaire were substantially more detailed (effectively short stories) than the single statement options presented in the DOSPERT.

Furthermore, while the factorial validity of this measure was evaluated in an unpublished report (Rohrmann, 2002), no further evaluation of internal consistency or any forms of cross-validation were reported in the literature. Consistent with the DOSPERT, Rohrmann (2002) stated that the low correlations between each of the RSQ domains suggest that risk orientation is quite heterogeneous under different contexts. The Risk Propensity Questionnaire (Nicholson, Soane, Fenton-O'Creevy, & Willman, 2005) also examines risk across various domains (recreational, health, career, financial,
safety and social risks), but in a far briefer format than either of the above two measures. This measure uniquely requests a rating for the likelihood of engaging in the behaviour in both the present and the past, consistent with theory and evidence that risk taking history has an impact on current risk propensity (Sitkin & Pablo, 1992; Sitkin & Weingart, 1995).

These general non-alcohol related risk propensity measures provide support for using similar principles to assess prospective alcohol-related risk taking. According to the basic premise of general risk assessments, a suitable strategy for collecting comparable data across subjects for different risk domains under circumstances of alcohol use and sobriety would be utilizing a self-reported hypothetical approach. Rating risky scenarios specifically relevant to alcohol use would offer an important compliment to measures which assess historical risk-taking behaviour, and can address some of the limitations associated with existing measures.

To address the limitations of existing measures, the present study evaluates a self-report scale that assesses multiple behaviours, across several domains, consistent with existing general risk assessments. Secondly, the new self-report scale specifically requests ratings for the likelihood to engage in risky behaviour under circumstances where alcohol has been consumed and when it has not so that clear comparisons can be made.

Dispositional Risk Validity

As part of evaluating the validity of the Hypothetical Alcohol Risk Measure (HARM), it is necessary to collect concurrent ratings of dispositional risk propensity. Dispositional risk assessment has been addressed in an extensive body of literature, notably through the development of self-report measures to explore individual differences in sensation seeking and impulsivity. These two constructs are thought to be critical precedents to risk taking behaviour and have resulted in two widely-validated
scales in this area of psychological research, namely, the Sensation Seeking Scale (SSS, Zuckerman, Eysenck, & Eysenck, 1978) and the Barratt Impulsivity Scale (BIS-11, Patton, Stanford, & Barratt, 1995). The SSS and BIS-11 have, across many studies, provided a means to evaluate propensity for a broad cross-section of risky behaviour by way of measuring present dispositional characteristics (e.g., “I am a careful thinker”) rather than recording instances of previous behaviour.

Sensation seeking is considered a biologically based personality characteristic, expressed as a need for physiological arousal, varied and novel experience, and a willingness to take social, physical, and financial risks to obtain such arousal (Bardo, Donohew, & Harrington, 1996; Zuckerman, 1979). Zuckerman (1979) developed the SSS to measure this construct and the scale has since undergone several revisions and psychometric evaluations. Ultimately, four subcomponents of sensation seeking have been identified - two subscales thought to measure more socially acceptable forms of sensation seeking (Experience Seeking and Boredom Susceptibility), and two subscales thought to measure less socially acceptable forms of sensation seeking (Thrill and Adventure Seeking, and Disinhibition) (Zuckerman, 1979, 1996; Zuckerman et al., 1978). Individuals who score highly on the SSS are not only more likely to engage in risky behaviour, but are also less likely to consider such behaviour as risky, leading them to underestimate risk (Hoyle, Stephenson, Palmgreen, Lorch, & Donohew, 2002).

Impulsivity is generally considered as a predisposition to engage in inappropriate or maladaptive behaviours without regard for the negative consequences (de Wit, 2009; Moeller et al., 2001). These inappropriate or maladaptive behaviours include actions which are counterproductive, poorly conceived, prematurely expressed, risky, or inappropriate in the context in which they are carried out, typically resulting in undesirable consequences (Dickman, 1989; Evenden, 1999; Stanford et al., 2009). The
impulsivity construct is used to explain normal individual differences in personality as well as more extreme personality pathology among clinical populations (de Wit, 2009; Stanford et al., 2009). Impulsivity is considered a symptom of several disorders including attention-deficit/hyperactivity disorder, borderline personality disorder, and antisocial personality disorder (American Psychiatric Association (APA) 2000). It also formed the basis for a separate section in the DSM-IV-TR entitled Impulsive Control Disorders not Elsewhere Classified, which included intermittent explosive disorder, kleptomania, pyromania, and pathological gambling (APA, 2000; Stanford et al., 2009). These disorders have since been moved the Disruptive, Impulse-control, and Conduct Disorders section of the DSM-5 (APA, 2013).

Operationally, impulsivity has been explored in a number of ways, including a preference for smaller and more immediate rewards over larger, delayed rewards, the inability to inhibit a prepotent response; as well as the self-reported perception of impulsive tendencies (de Wit, 2009). Development of the BIS-11 yielded several subcomponents consistent with these operationalizations: Cognitive Impulsiveness (making quick decisions), Motor Impulsiveness (acting without thinking), and Non-Planning Impulsiveness (lack of forethought) (Barratt, 1985; Stanford et al., 2009). Scholars have argued that some items on the SSS overlap considerably with those on the BIS-11, suggesting that some dimensions of impulsivity are likely similar to that of sensation seeking (Steinberg, 2008). Research has confirmed that the two scales are correlated (e.g., .35, Lejuez et al., 2002).

Importantly, both measures are associated with alcohol problems, with evidence that sensation seeking predicts higher levels of alcohol use (Crawford, Pentz, Chou, Li, & Dwyer, 2003; Hittner & Swickert, 2006) and problematic drinking in student (e.g., Stacy, Newcomb, & Bentler, 1993) and clinical samples (Liraud & Verdoux, 2000). Furthermore, alcoholics exhibit elevated sensation seeking scores compared to healthy
controls (Noël et al., 2011). Research by Fein, Di Sclafani, and Finn (2010) suggests that sensation seeking normalizes in long term abstinent alcoholics as they score lower than active drinkers on the SSS. Finn, Mazas, Justus, and Steinmetz (2002) suggested that sensation seeking reflects a predisposition toward excessive alcohol use, which is partly an increased sensitivity of appetitive motivational processes. Therefore it would be expected that sensation seeking scores would be related to measures of reward sensitivity, such as the Behavioural Activation Scale (BAS; Carver & White, 1994).

Impulsivity, as measured by the BIS-11, has also shown associations with increased alcohol use and problematic drinking outcomes in college community samples (Balodis et al., 2009; Lejuez et al., 2002). BIS scores are also related to an increased likelihood of having a substance use disorder and earlier onset of alcohol use (von Diemen, Bassani, Fuchs, Szobot, & Pechansky, 2008). Furthermore, alcohol-dependents and abstinent alcoholics exhibit elevated scores compared to healthy controls (Lawrence, Luty, Bogdan, Sahakian, & Clark, 2009b; J. M. Mitchell, Fields, D'Esposito, & Boettiger, 2005). Consistent with Gray’s Reinforcement Sensitivity Theory (1987b, 1994), impulsivity is an important contributor to reward sensitivity in substance users.

Because of the widely supported link between sensation seeking and impulsivity with self-reported risky behaviours, including alcohol use, these constructs have been established as essential in estimating risk propensity as relevant to alcohol use. Therefore, any newly developed measure designed to specifically assess alcohol-related risky behaviour, can have elements of its validity confirmed through its association with the constructs assessed by these two measures (Rohrmann, 2002). Furthermore, exposure to risk is typically motivated by the possibility of a reward (e.g., sexual intercourse) so, consistent with previous chapters, the Behavioural Activation Scale
(BAS) was also included to provide a measure of reward sensitivity, which is also likely to correlate positively with the newly developed risk measure.

The Present Study

Previous studies have developed assessment methods for collecting historical behaviours related to alcohol use, estimating prospective propensity for general risk and measuring related dispositional constructs such as impulsivity, sensation seeking and reward sensitivity. However, no study has validated a self-report assessment of hypothetical risk scenarios which measures the influence of alcohol on risky behaviour across several domains. An advantage of such an approach is that it eliminates some drawbacks associated with self-report, such as accuracy of recollection and admission to illegal or unethical behaviours. Importantly, it also allows all participants to be compared under conditions of alcohol involvement and sobriety across a variety of behaviours, regardless of whether they have encountered that situation before. The development of such an assessment strategy offers a potentially useful compliment to the behavioural measures already explored in this thesis.

The development and validation of the HARM was achieved in a three-step process. Firstly, multiple items were generated for several broad risk categories considered relevant to emerging adult populations. These included scenarios that could result in sexual, social/ethical, financial, legal, and injurious consequences. Furthermore, these items also varied in their risk severity (e.g., minor versus potentially fatal injuries, large versus small financial losses). Each scenario required a rating for the likelihood of the risky consequence under circumstances of drinking and of not drinking. That is, each scenario was to be rated twice so comparisons could be made between drinking and sober circumstances. Additionally, four items were generated specifically to measure drinking and driving related risk. In this case there could be no
sober comparison, as there is not a clear comparative consequence associated with sober driving.

Secondly, a large online administration of the new items alongside several established self-report measures was conducted. Given the sensitive nature of some of the items, it was anticipated that using an anonymous online data collection method would yield more accurate reports (Greist et al., 1987). Furthermore, a sample of young adults was selected because they are typically characterised by a prevalence of risky behaviour, including those who are alcohol influenced (Steinberg, 2008). Once these data were collected, a random subsample was taken to perform an Exploratory Factor Analysis (EFA) in order to identify the number of relevant factors and suitable items for the factor solutions.

Thirdly, the remaining cases were subjected to a Confirmatory Factor Analysis (CFA) to confirm that the model suggested by the EFA provides a good fit to the data in an independent sample. Following this step, estimates of reliability were calculated and convergent validity was estimated through associations between HARM and several existing risk measures that have been well validated in the literature.

Finally, criterion validity was evaluated by using comparison tests to determine that risk propensity was higher under drinking conditions than sobriety conditions, and that propensity for risk was more prevalent in males (than females) and individuals classified as higher (compared to lower) risk drinkers by the AUDIT.

The present study included three aims. This first aim involved exploration and confirmation of useful subscales of the HARM and estimates of their internal consistency. Secondly, the present study aimed to show evidence of factorial and convergent validity by demonstrating that the factorial structure of the subscales adhered to distinct risk domains, and that the composite scores of these subscales are positively associated with well validated measures of risk taking constructs. In addition,
and consistent with the premise of previous chapters, the relationship between alcohol craving (approach and avoidance - at a trait level) and risk propensity on the HARM was also examined. Thirdly, the present study aimed to compare risk propensity ratings between drinking and non-drinking scenarios and across different gender and risk groups. This was to determine if the involvement of alcohol is perceived to increase risk propensity as a function of gender and categories of misuse (low versus high risk).

In line with these aims and following the confirmation of the HARM items via an EFA and CFA, three predictions were made:

(1) (a) Subscale composite scores of the new measure will positively correlate with well-validated measures of risk propensity constructs such as impulsivity, sensation seeking, and reward sensitivity. (b) Consistent with previous chapters of this thesis, the HARM will be further validated through a positive association with approach inclinations toward alcohol, and a negative association with avoidance inclinations toward alcohol.

(2) There would be a significant difference between ratings of risky behaviour in scenarios where alcohol has been perceived to be consumed compared to scenarios where alcohol has not. This would be indicated by a higher propensity to engage in the proposed risky behaviour when alcohol is consumed.

(3) (a) Consistent with evidence that males exhibit riskier behaviour than females (Arnett, 1996; Byrnes et al., 1999; Duangpatra et al., 2009; Jessor et al., 1997), the validity of the HARM will be supported by significant differences in risky behaviour between the genders under circumstances of perceived alcohol consumption as well as sobriety. (b) Furthermore, consistent with the rationale for earlier chapters in this thesis, groups separated into risk categories using the AUDIT will also show significant differences in risk propensity based on the
new measure. Specifically, those categorized as risky to very risky drinkers would score higher than those categorized as low risk drinkers.

Method

Participants

Participants were 481 (60.3% female) undergraduate psychology students aged between 17 and 55 ($M = 20.28, SD = 4.73$) at the University of Western Australia, selected from a larger screening sample. Participants were selected if they reported drinking alcohol within the last three months and recorded a score of at least one on the AUDIT ($M = 9.49, SD = 5.58$). Most participants were Caucasian ($n = 369, 76.7$%), with 13.7% ($n = 66$) reporting Asian ethnicity, and the remaining 9.6% reporting Aboriginal ($n = 4$), Hispanic ($n = 3$), Pacific ($n = 3$), African ($n = 20$) or ‘mixed’ ($n = 16$) ethnicities. All participants provided informed consent before participating in the study and received course credit upon completion.

Materials

As per previous studies in this thesis, the Drinking Behaviour Questionnaire, AUDIT, Behavioural Inhibition and Activation Scales (BIS/BAS), and Approach and Avoidance of Alcohol Questionnaire (AAAQ) were included in the battery of measures administered. The only difference in the above measures to previous chapters is that the version of the AAAQ used requested participants complete it in view of experiences within the “last week”, rather than “right now”. (e.g., “I would have liked to have a drink or two” versus “I would like a drink or two”). New materials used are listed below.

Hypothetical Alcohol Risk Measure (HARM). This newly developed measure initially consisted of 21 items each presenting a different brief hypothetical scenario and a risky behaviour that could ensue (see Appendix). For 17 of these items, participants
rated the likelihood of engaging in the risky behaviour twice, once to represent circumstances where they have been drinking and once to represent the same circumstance but if they were sober. Four additional items referred specifically to potential drink-driving behaviours which included a single response option (only under drinking circumstances, as that was the risk component of the scenario, e.g., “Imagine you stayed late at work and had a few drinks when you normally drive home. You are feeling quite drunk and you need to get home. How likely would you be to drive yourself home and risk a traffic accident?”). The first 17 items covered a broad range of risky scenarios which could result in negative consequences across a variety of domains, including, sexual, social/ethical, financial, legal and injurious. A 5-point rating scale anchored from ‘Not Very Likely at All’ to ‘Very Likely’ indicated the participant’s likelihood of engaging in the proposed risky behaviour for each possible circumstance.

**Brief Sensation Seeking Scale (BSSS, Hoyle et al., 2002).** This 8-item self-report measure was adapted from Form V of the 40-item Sensation Seeking Scale (Zuckerman et al., 1978) and presents two items from each of the original subscales; Experience Seeking, Boredom Susceptibility, Thrill and Adventure Seeking, and Disinhibition. The latter two scales are considered to comprise items reflecting less acceptable forms of sensation seeking (e.g., “I like to do frightening things”), whereas the former two are more socially acceptable (e.g., “I get restless when I spend too much time at home”). Responses are made on a 5-point Likert scale anchored from ‘Strongly Disagree’ to ‘Strongly Agree’. This version was developed to improve brevity and resolve issues with cumbersome, forced choice response options as well as out-dated words and phrases. A further advantage of this revised version is that items referring to alcohol or drug use have been eliminated, making it a separate risk assessment to one involving substance use. Those scoring highly on this measure are considered to be high
in sensation seekers and more likely to engage in risky behaviour (Hoyle et al., 2002). The present data yielded acceptable internal consistency reliability across all items ($\alpha = .76$), identical to that reported by the original validation study (Hoyle et al., 2002). According to the factor analysis conducted by Hoyle et al. (2002), this version of the scale adhered to a single factor model, and therefore only a single overall composite will be calculated in the present study.

**Barratt Impulsivity Scale (BIS-11, Patton et al., 1995).** This widely-used 30-item self-report measure is designed to evaluate impulsiveness. It comprises three (second order) subscales which are Cognitive Impulsiveness, (making quick decisions), Motor Impulsiveness (acting without thinking), and Non-Planning Impulsiveness (lack of forethought). Responses are made on a 4-point scale anchored from Rarely/Never to Almost Always/Always. Scoring highly on the BIS-11 has been frequently associated with a range of negative behavioural outcomes (Dom, D’haene, Hulstijn, & Sabbe, 2006a; Dougherty, Mathias, Marsh, Papageorgiou, & et al., 2004; Lejuez et al., 2002; Smith, Waterman, & Ward, 2006; Stanford et al., 2009). A total cut-off score of 74 has been previously used as a criterion for an individual to be considered impulsive (Stanford et al., 2009). The BIS-11 yielded an acceptable internal consistency estimate ($\alpha = .82$) in the present sample.

**Procedure**

A similar recruitment procedure was used as Study 2, whereby the AUDIT and the Drinking Behaviour Questionnaire were administered during a large pre-screen session in first year psychology classes. In this study however, eligible participants were then sent an email invitation and a web link to participate in an online administration of the listed measures delivered using Qualtrics (Qualtrics, Provo, UT). Consent was obtained digitally prior to the presentation of the questionnaires. Upon completion,
participants were directed to a debriefing page and subsequently given partial course credit. It took most participants between 20 to 30 minutes to complete the battery of questionnaires.

**Results**

**Psychometric Analysis of the HARM Items**

An initial 413 cases were collected from the online administration. From this, a random subsample of 150 cases were extracted, and, to increase this subsample size, a further 68 cases were added from a related concurrent laboratory study with the same administration procedure (computer-based survey). This totalled to 218 cases for the purpose of an EFA of the newly developed HARM items. The remaining 263 cases from the online administration were used for a subsequent CFA.

**EFA: Sober Scale**

In order to explore the dimensionality of each of the scales, a Maximum Likelihood Estimation (MLE) analysis was performed separately for each scale. Firstly, a scree plot analysis was performed and examined for the sober scale to determine the number of components to extract (see Figure 1).
Figure 1. Scree plot associated with the sober risk scale.

As can be seen in Figure 1, four eigenvalues were observed above the scree with a minimum value of 1.25. Extracting four factors from the MLE (direct oblimin rotation), resulted in four somewhat ambiguous factors. However, the removal of several items improved the clarity of this solution. Firstly, Items 12 (injurious risk) and 6 (financial risk), which had very low comparable communalities (.05 and .10 respectively), were removed. Secondly, item 7 (financial risk), which cross-loaded (both .35) across two factors that appeared related to ethical and injurious risk was also removed. Following a further iteration of the analysis, items 1 and 2 (ethical risk) remained as the only items on a single factor. These two items were removed because a minimum of three items is considered appropriate for a stable factor (Comrey, 1988; Floyd & Widaman, 1995; Guadagnoli & Velicer, 1988) and they could not be redistributed to other factors using a three factor solution. Following these item exclusions, three factors were extracted, resulting in a clearer solution. These factors comprised item clusters consistent with Legal risk, Sexual Risk, and Injurious Risk.
Item 8 (financial risk) was subsequently removed because it was loading on the Injurious Risk factor.

The MLE analysis was performed again with the remaining 11 items. Examination of the pattern matrix loadings confirmed three clear factors (see Table 1). The first factor consisted of an unrotated eigenvalue of 3.69 and accounted for 33.6% of the total variance (rotated eigenvalue = 2.14). As can be seen in Table 1, the factor loadings which defined the first factor consisted of items referring to opportunities to engage in illegal behaviour and was thus labelled ‘Legal Risk’. The second factor consisted of an unrotated eigenvalue of 1.46 and accounted for 13.3% of the variance (rotated eigenvalue = 2.19). As can be seen in Table 1, the component loadings which defined the second factor consisted of items referring to opportunities to engage in problematic sexual behaviour and was thus labelled ‘Sexual Risk’. The third factor consisted of an unrotated eigenvalue of 1.21 and accounted for 11.0% of the variance (rotated eigenvalue = 2.59). As can be seen in Table 1, the component loadings which defined the first component consisted items referring to opportunities to engage in injurious behaviour and was thus labelled ‘Injurious Risk’.

The 11-item, three factor solution explained a total variance of 46.0%.
Table 1

*Communalities and Component Loadings for a Three Factor Solution (Sober Scale)*

<table>
<thead>
<tr>
<th>Item</th>
<th>( h )</th>
<th>( \lambda )</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 (Legal) - Imagine you are at a bottle shop purchasing some drinks when some underage friends ask you to buy them some alcohol before they drive to a party. How likely would you be to purchase alcohol for your friends and risk a heavy fine?</td>
<td>1.00</td>
<td><strong>1.00</strong></td>
</tr>
<tr>
<td>10 (Legal) - Imagine you are at a bottle shop purchasing some drinks when some underage friends ask you to buy them some alcohol as well. How likely would you be to purchase alcohol for your friends and risk a heavy fine?</td>
<td>.44</td>
<td>.62</td>
</tr>
<tr>
<td>9 (Legal) - Imagine you have no money on you and you need a drink of water. You notice a newsagent stand has a fridge with water in it that you could easily take a bottle from. How likely would you be to steal the water and risk being caught?</td>
<td>.15</td>
<td>.27</td>
</tr>
<tr>
<td>5 (Sexual) - Imagine you have the opportunity to engage in some sexual activity that might cause you some real trouble later on. How likely would you be to engage in sexual activity and risk serious consequences?</td>
<td>.67</td>
<td>.02</td>
</tr>
<tr>
<td>4 (Sexual) - Imagine you have the opportunity to engage in some sexual activity that you know you might later regret. How likely would you be to engage in sexual activity and risk later feeling shame or regret?</td>
<td>.61</td>
<td>-.12</td>
</tr>
<tr>
<td>3 (Sexual) - Imagine you have the opportunity to have sex with a casual partner but neither of you have a condom. How likely would you be to have sex with this casual partner and risk a Sexually Transmitted Infection or unwanted pregnancy?</td>
<td>.35</td>
<td>.18</td>
</tr>
<tr>
<td>17 (Injurious) - Imagine you have gone out to some sand dunes with some friends and someone asks you if you want to drive their quad bike up a steep and rocky embankment where someone was recently killed doing the same activity. How likely would you be to drive the bike up the embankment and risk severe injury or death?</td>
<td>.52</td>
<td>.00</td>
</tr>
<tr>
<td>15 (Injurious) - Imagine you are socializing with some friends on a 3rd story balcony and someone challenges you to jump into the backyard pool, which is adjacent but not directly below. How likely would you be to jump into the pool and risk severe injury or death?</td>
<td>.43</td>
<td>.08</td>
</tr>
<tr>
<td>13 (Injurious) - Imagine you visiting some friends on a farm and you are given the opportunity to operate a chainsaw on your own for the first time. How likely would you be to operate the chainsaw and risk severe injury?</td>
<td>.41</td>
<td>-.04</td>
</tr>
<tr>
<td>16 (Injurious) - Imagine you are socializing with some friends at night at a beach where you know there are strong riptides. Someone suggests swimming 75 metres out to a pontoon. How likely would you be to swim out 75 metres and risk drowning in the strong current?</td>
<td>.33</td>
<td>.09</td>
</tr>
<tr>
<td>14 (Injurious) - Imagine you are in a line for a taxi late after a night out. The person behind you becomes aggravated and begins verbally abusing you then starts to push you around a bit. How likely would you be to respond aggressively and risk getting injured or legal trouble?</td>
<td>.14</td>
<td>-.04</td>
</tr>
</tbody>
</table>

\( h = \) Communalities, \( \lambda = \) Factor Loadings
Next, a Partial Confirmatory Factor Analysis (PCFA) was performed (Gignac, 2009), to estimate several close fit indices to assist in evaluating the suitability of the solution for a CFA. The fit indices used were; root mean square error of approximation (RMSEA; M. W. Brown & Cudek, 1993), whereby values between .08 to .06 or less indicate acceptable model fit (Hu & Bentler, 1999); Normed fit index (NFI; Bentler & Bonett, 1980), the Tucker–Lewis Index (TLI; Tucker & Lewis, 1973) and the Comparative Fit Index (CFI; Bentler, 1990), whereby values of .950 or larger indicate acceptable model fit (Hu & Bentler, 1999).

Based on the null (Bartlett’s Test of Sphericity) and implied chi-square (MLE chi-square) values, the close fit index values were estimated to be RMSEA = .067, NFI = .924, TLI = .909, CFI = .958, which if taken together, suggest an adequate fit for the model. If only considering RMSEA and CFI, it would be appropriate to justify a CFA.

**EFA: Drinking Scale**

A scree plot analysis was performed and examined for the drinking scale to determine the number of components to extract (see Figure 2).
Figure 2. Scree plot associated with the drinking risk scale.

As can be seen in Figure 2, three eigenvalues were observed above the scree, each with a minimum value of 1.80. Extracting three factors from the MLE (direct oblimin rotation), resulted in three somewhat ambiguous factors. To improve the clarity of the solution, several items were removed. Item 9 (legal risk) cross-loaded (.26 and .30) over two factors (related to driving risk and a combination of other unrelated risk items), and item 12 (injurious risk), which possessed a low communality (.07), were both removed. The iteration following this resulted in one factor consisting of only two items (1 and 2, ethical risk), which, being below the minimum of three items for a stable factor, were removed. The scree plot still suggested three factors be extracted, which was performed, resulting in a slightly clearer factor solution. These factors comprised item clusters consistent with Motor Vehicle Risk, Sexual Risk, and Injurious Risk. However, there were still several more problematic items that needed to be removed to further improve the clarity of the solution. Item 6 (financial risk) possessed a comparably low communality (.17) and two low cross-loadings on the sexual (.23) and
injurious (.20) factors, so it was removed. Item 14 (injurious risk) possessed a low loading (.24) on its respective factor and equally cross-loaded onto the motor vehicle factor (.24), so was removed. Items 7 and 8 (financial risk) were removed because they loaded heavily on to the injurious factor and thus were not conceptually related nor would it be appropriate to attempt to redistribute them to the motor vehicle or sexual risk factor. Furthermore, items 10 and 11 (legal risk) were removed from the sexual risk factor for the same reason. These conceptual removals allowed the sexual and injurious factor items to be kept consistent with the factor item solution of the sober scale. After the aforementioned removals, a further iteration of the analysis revealed that item 21 (motor vehicle risk) now possessed a comparatively weak primary loading (.37 versus .69, .81, & .97) on the driving risk factor and a cross-loading on the injurious risk factor (.28), so it was also removed.

The MLE was performed again with the remaining 10 items. Examination of the pattern matrix loadings now suggested three clear factors (see Table 2). The first factor consisted of an unrotated eigenvalue of 3.87 and accounted for 38.7% of the total variance (rotated eigenvalue = 2.59). As can be seen in Table 2, the factor loadings which defined the first factor refer to items representing opportunities to enter a motor vehicle with, or as, an intoxicated driver and was labelled ‘Motor Vehicle Risk’ and does not have corresponding items in the sober scale. The second factor consisted of an unrotated eigenvalue of 1.69 and accounted for 16.9% of the variance (rotated eigenvalue = 2.52). As can be seen in Table 2, the factor loadings which defined the second factor consisted of items referring to opportunities to engage in problematic sexual behaviour and was thus labelled ‘Sexual Risk’, matching the second factor of the sober scale. The third factor consisted of an unrotated eigenvalue of 1.28 and accounted for 12.8% of the variance (rotated eigenvalue = 2.41). As can be seen in Table 2, the factor loadings which defined the third factor consisted of items referring to
opportunities to engage in injurious behaviour and was thus labelled ‘Injurious Risk’, matching the third component of the sober scale.

The 10-item, three factor solution explained a total variance of 56.8%.
Table 2

**Communalities and Factor Loadings for a Four Factor Solution (Drinking Scale)**

<table>
<thead>
<tr>
<th>Item</th>
<th>h</th>
<th>λ</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>19 (Motor Vehicle) - Imagine you promised your friend you would pick them up from the airport after work, however you knocked off early and went drinking with your colleagues. When it is time to leave to pick up your friend, you think you are fine to drive but are over the limit. How likely would you be to drive to the airport and risk being caught for drink driving?</td>
<td>.93</td>
<td>.98</td>
<td>.00</td>
<td>-.05</td>
<td></td>
</tr>
<tr>
<td>18 (Motor Vehicle) - Imagine you have been out drinking with friends and you are quite drunk. The friend that had offered to drive everyone home in your car had left early already. How likely would you be to drive your friends home and risk a traffic accident?</td>
<td>.63</td>
<td>.79</td>
<td>-.10</td>
<td>.11</td>
<td></td>
</tr>
<tr>
<td>20 (Motor Vehicle) - Imagine you have been out drinking with friends. One of your friends had offered to drive at the start of the night, however when it is time to drive home they appear quite drunk. How likely would you to accept a lift with your friend and risk being in a traffic accident?</td>
<td>.53</td>
<td>.67</td>
<td>.12</td>
<td>.03</td>
<td></td>
</tr>
<tr>
<td>5 (Sexual) - Imagine you have the opportunity to engage in some sexual activity that might cause you some real trouble later on. How likely would you be to engage in sexual activity and risk serious consequences?</td>
<td>.69</td>
<td>-.05</td>
<td>.81</td>
<td>.07</td>
<td></td>
</tr>
<tr>
<td>4 (Sexual) - Imagine you have the opportunity to engage in some sexual activity that you know you might later regret. How likely would you be to engage in sexual activity and risk later feeling shame or regret?</td>
<td>.65</td>
<td>-.13</td>
<td>.78</td>
<td>.13</td>
<td></td>
</tr>
<tr>
<td>3 (Sexual) - Imagine you have the opportunity to have sex with a casual partner but neither of you have a condom. How likely would you be to have sex with this casual partner and risk a Sexually Transmitted Infection or unwanted pregnancy?</td>
<td>.53</td>
<td>.23</td>
<td>.66</td>
<td>-.10</td>
<td></td>
</tr>
<tr>
<td>16 (Injurious) - Imagine you are socializing with some friends at night at a beach where you know there are strong riptides. Someone suggests swimming 75 metres out to a pontoon. How likely would you be to swim out 75 metres and risk drowning in the strong current?</td>
<td>.54</td>
<td>-.05</td>
<td>-.08</td>
<td>.78</td>
<td></td>
</tr>
<tr>
<td>17 (Injurious) - Imagine you have gone out to some sand dunes with some friends and someone asks you if you want to drive their quad bike up a steep and rocky embankment where someone was recently killed doing the same activity. How likely would you be to drive the bike up the embankment and risk severe injury or death?</td>
<td>.55</td>
<td>.04</td>
<td>.02</td>
<td>.72</td>
<td></td>
</tr>
<tr>
<td>15 (Injurious) - Imagine you are socializing with some friends on a 3rd story balcony and someone challenges you to jump into the backyard pool, which is adjacent but not directly below. How likely would you be to jump into the pool and risk severe injury or death?</td>
<td>.42</td>
<td>.04</td>
<td>.07</td>
<td>.60</td>
<td></td>
</tr>
<tr>
<td>13 (Injurious) - Imagine you visiting some friends on a farm and you are given the opportunity to operate a chainsaw on your own for the first time. How likely would you be to operate the chainsaw and risk severe injury?</td>
<td>.20</td>
<td>.10</td>
<td>.12</td>
<td>.34</td>
<td></td>
</tr>
</tbody>
</table>

\( h = \) Communalities, \( \lambda = \) Factor Loadings
Next, a Partial Confirmatory Factor Analysis (PCFA) was performed to estimate several close fit indices to assist in evaluating the suitability of the solution for a CFA (Gignac, 2009). Based on the null (Bartlett’s Test of Sphericity) and implied chi-square (MLE chi-square) values, the close fit index values were estimated to be RMSEA = .036, CFI = 1.01\(^4\), TLI = 1.02, NFI = .984, suggesting a potentially good fit for the model, therefore justifying a subsequent CFA.

Examination of Table 1 (Sober Scale) and Table 2 (Drinking Scale) reveal that only two factors were represented consistently, in terms of their items, across both sober and drinking scales (Sexual Risk and Injurious Risk – with the exclusion of item 14 from the sober scale because it could not be retained in the drinking scale due to equally weak cross-loadings). This suggests that these two components are most suitable for constructing a scale for comparing risk behaviour across circumstances of sobriety and drinking. Because the Legal Risk scale is unique to the sober scale, it has limited utility since a comparison of risk propensity between sober and drinking conditions across this domain would not be valid. By disregarding this independent scale, a 10-item scale (7 shared items plus the motor vehicle items) is yielded based on the extraction of two components from the sober scale and three from the drinking scale. This was with the additional factor on the drinking scale representing the unique subscale relevant only to that scale (motor vehicle risk). The outcome of the EFA suggests that risk propensity comparisons can be validly calculated between sober and drinking circumstances for risky sexual and injurious behaviours. The revised two factor solution for the sober scale, with the exclusion of item 14 and the Legal Risk items, is reported in Table 3, the drinking scale remains the same as shown in Table 2.

\(^4\) As PCFA is an estimation procedure, values may marginally exceed ceiling limits
Table 3

*Revised Communalities and Factor Loadings for a Two Factor Solution (Sober Scale)*

<table>
<thead>
<tr>
<th>Item</th>
<th>( h )</th>
<th>( \lambda )</th>
<th>( 1 )</th>
<th>( 2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 (Sexual)</td>
<td>.66</td>
<td>.83</td>
<td>-.03</td>
<td></td>
</tr>
<tr>
<td>4 (Sexual)</td>
<td>.61</td>
<td>.78</td>
<td>.01</td>
<td></td>
</tr>
<tr>
<td>3 (Sexual)</td>
<td>.31</td>
<td>.54</td>
<td>.02</td>
<td></td>
</tr>
<tr>
<td>17 (Injurious)</td>
<td>.57</td>
<td>-.03</td>
<td>.77</td>
<td></td>
</tr>
<tr>
<td>15 (Injurious)</td>
<td>.40</td>
<td>-.02</td>
<td>.64</td>
<td></td>
</tr>
<tr>
<td>16 (Injurious)</td>
<td>.33</td>
<td>.03</td>
<td>.59</td>
<td></td>
</tr>
<tr>
<td>13 (Injurious)</td>
<td>.37</td>
<td>.17</td>
<td>.52</td>
<td></td>
</tr>
</tbody>
</table>

\( h = \) Communalities, \( \lambda = \) Factor Loadings

A PCFA suggested that, based on the revised sober scale solution, the close fit indices, RMSEA = .055, CFI = .985, TLI = .962, NFI = .966, estimated an improved and potentially good fit for the model, justifying the continuation with a CFA.

**Reliability Analysis: \( N = 218 \)**

Next, a reliability analysis was performed on the resultant scales. Firstly the corrected item-total correlations were examined to determine if the internal consistency of the sober and drinking scales could be improved by removing inadequate items, which would be indicated by an item-total correlation of .30 or less (Nunnally & Bernstein, 1994). All item-total correlations for both scales exceeded .30 and there was no indication that alpha could be improved through item removal. For all the sober scale
items, Cronbach’s α was estimated at .75, and for all the drinking scale items, Cronbach’s α was estimated at .82, both of which are considered acceptable for research purposes (Nunnally & Bernstein, 1994). To determine if it would be justifiable to calculate composite scores for each of the subscales, alpha estimates were also calculated for the Sexual Risk, Injurious Risk and Motor Vehicle Risk subscales of both sober and drinking scales (see Table 4), with all demonstrating acceptable or marginal internal consistency reliability.

Table 4

*Cronbach’s Alpha Estimates for Sober and Drinking Subscales*

<table>
<thead>
<tr>
<th></th>
<th>Sexual α</th>
<th>Injurious α</th>
<th>Motor Vehicle α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sober</td>
<td>.73</td>
<td>.69</td>
<td>-</td>
</tr>
<tr>
<td>Drinking</td>
<td>.80</td>
<td>.72</td>
<td>.85</td>
</tr>
</tbody>
</table>

The descriptive statistics were calculated for the 7-item sober and 10-item drinking scales (see Table 5) with both the inter-item mean correlations suggesting a medium effect size (Cohen, 1992) and skew and kurtosis values suggesting approximately normally distributed scores.

Table 5

*Descriptive Statistics for Sober and Drinking Scales Following EFA*

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Skew</th>
<th>Kurtosis</th>
<th>Mean Inter-item $r$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sober Scale</td>
<td>1.53</td>
<td>.56</td>
<td>1.42</td>
<td>1.79</td>
<td>.32</td>
</tr>
<tr>
<td>Drinking Scale</td>
<td>1.86</td>
<td>.64</td>
<td>.84</td>
<td>.08</td>
<td>.32</td>
</tr>
</tbody>
</table>
CFA: Sober and Drinking Scales

Prior to testing the hypotheses and to provide evidence for the construct validity of the above factor structure, a CFA was conducted on the remaining 263 cases. Both CFAs were conducted using an MLE via AMOS 22.

The seven sober items were subjected to a CFA based on the two factor model suggested by the EFA. The oblique two-factor model yielded a $\chi^2 = 24.76$ (13, N = 263), $p = .025$, with close fit indices, RMSEA = .059, CFI = .970, TLI = .952, NFI = .940, indicating that the model was well-fitting. As shown in Figure 3, all of the factor loadings were positive and significant ($p < .001$) suggesting that the two factors were well defined. The correlation between the two factors was also significant ($p < .001$)

Figure 3. Illustration of the two factor model associated with the seven sober items with factor loadings and factor correlation.
The two-factor model was considered to be a significantly better fit than a single factor solution for the seven items, indicated by a chi square difference test, $\chi^2 (2) = 130.90, p < .001$.

The ten drinking items were also subject to a CFA based on the three factor model suggested by the EFA. The oblique three-factor model yielded a $\chi^2 = 44.66 (32, N = 263), p = .07$, with close fit indices, RMSEA = .039, CFI = .981, TLI = .974, NFI = .938, indicating that the model was well-fitting. As shown in Figure 4, all of the factor loadings were positive and significant ($p < .001$) suggesting that the three factors were well defined. The correlations between the three factors were also significant ($p < .001$).

Figure 4. Illustration of the three factor model associated with the ten items with factor loadings and correlations.
The three-factor model was considered to be a significantly better fit than a single factor solution for the 10 items, indicated by a chi square difference test, $\chi^2(3) = 296.14, p < .001$.

Reliability Analysis: $N = 263$

Next, a reliability analysis was performed on the resultant scales in the independent sample. Firstly the corrected item-total correlations were examined to determine if the internal consistency of the sober and drinking scales could be improved by removing inadequate items, which would be indicated by an item-total correlation of .30 or less (Nunnally & Bernstein, 1994). All item-total correlations for both scales exceeded .30 and there was no indication that alpha could be improved through item removal. For all the sober scale items, Cronbach’s $\alpha$ was estimated at .71, and for all the drinking scale items, Cronbach’s $\alpha$ was estimated at .76, both of which are considered acceptable for research purposes (Nunnally & Bernstein, 1994). To determine if it would be justifiable to calculate composite scores for each of the subscales, alpha estimates were also calculated for the Sexual Risk, Injurious Risk and Motor Vehicle Risk subscales of both sober and drinking scales (see Table 6), all with weaker internal consistency reliability than the EFA sample.

Table 6

<table>
<thead>
<tr>
<th></th>
<th>Sexual $\alpha$</th>
<th>Injurious $\alpha$</th>
<th>Motor Vehicle $\alpha$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sober</td>
<td>.71</td>
<td>.66</td>
<td>-</td>
</tr>
<tr>
<td>Drinking</td>
<td>.79</td>
<td>.64</td>
<td>.75</td>
</tr>
</tbody>
</table>

The descriptive statistics were calculated for the sober and drinking scales (see Table 7) with both the inter-item mean correlations approaching a medium effect size.
(Cohen, 1992) and skew and kurtosis values suggesting approximately normally distributed scores.

Table 7

*Descriptive Statistics for Sober and Drinking Scales Following CFA*

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Skew</th>
<th>Kurtosis</th>
<th>Mean Inter-item r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sober Scale (7 items)</td>
<td>1.50</td>
<td>.53</td>
<td>2.02</td>
<td>6.97</td>
<td>.27</td>
</tr>
<tr>
<td>Drinking Scale (10 items)</td>
<td>1.73</td>
<td>.52</td>
<td>1.06</td>
<td>2.08</td>
<td>.25</td>
</tr>
</tbody>
</table>

**Construct Validity of the HARM**

Descriptive statistics and inter-correlations for the AUDIT, BIS/BAS subscales, AAAQ, BSSS and BIS-11 subscales are presented in Table 8.
### Table 8

**Descriptive Statistics and Inter-correlations for the AUDIT, BIS/BAS subscales, AAAQ, BSSS and BIS-11 subscales**

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. AUDIT</td>
<td>9.40</td>
<td>5.40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. BAS – Fun Seeking</td>
<td>11.92</td>
<td>2.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. BAS - Drive</td>
<td>11.02</td>
<td>1.99</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. BAS – Reward Response</td>
<td>16.83</td>
<td>2.01</td>
<td>.17**</td>
<td>.45**</td>
<td>.44**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. BIS$^{inhb}$</td>
<td>21.14</td>
<td>3.57</td>
<td>.01</td>
<td>-.16**</td>
<td>-.07</td>
<td>.31**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. AAAQ – Obs/Com</td>
<td>1.56</td>
<td>1.72</td>
<td>.51**</td>
<td>.10</td>
<td>.11</td>
<td>.03</td>
<td>.06</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. AAAQ – Inc/Ind</td>
<td>5.21</td>
<td>1.90</td>
<td>.44**</td>
<td>.17**</td>
<td>.00</td>
<td>.19**</td>
<td>.18**</td>
<td>.47**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. AAAQ – Res/Reg</td>
<td>1.65</td>
<td>1.48</td>
<td>.22**</td>
<td>.02</td>
<td>.04</td>
<td>-.09</td>
<td>-.03</td>
<td>.39**</td>
<td>.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. BSSS</td>
<td>3.40</td>
<td>.66</td>
<td>.33**</td>
<td>.61**</td>
<td>.31**</td>
<td>.26**</td>
<td>-.17**</td>
<td>.17**</td>
<td>.15*</td>
<td>.09</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. BIS -11 – Cog Imp</td>
<td>18.41</td>
<td>3.83</td>
<td>.20**</td>
<td>.18**</td>
<td>.11</td>
<td>.17**</td>
<td>.16**</td>
<td>.24**</td>
<td>.10</td>
<td>.19**</td>
<td>.26**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. BIS -11 – Motor Imp</td>
<td>23.69</td>
<td>4.33</td>
<td>.21**</td>
<td>.46**</td>
<td>.25**</td>
<td>.10</td>
<td>-.18**</td>
<td>.20**</td>
<td>.07</td>
<td>.12</td>
<td>.34**</td>
<td>.42**</td>
<td></td>
</tr>
<tr>
<td>12. BIS -11 – Non-Plan</td>
<td>25.21</td>
<td>4.45</td>
<td>.23**</td>
<td>.28**</td>
<td>-.06</td>
<td>.04</td>
<td>-.03</td>
<td>.12*</td>
<td>.08</td>
<td>.04</td>
<td>.21**</td>
<td>.40**</td>
<td>.46**</td>
</tr>
</tbody>
</table>

*p < .05, **p < .01; AUDIT = Alcohol Use Disorders Inventory Test; BAS = Behavioral Activation Scale; BIS = Behavioral Inhibition Scale; AAAQ = Approach and Avoidance of Alcohol Questionnaire; BSSS = Brief Sensation Seeking Scale; BIS-11 = Barratt Impulsivity Scale.
To address the prediction (1) that the newly developed subscales are positively correlated with validated dispositional risk measures and alcohol craving, Pearson correlations were conducted between HARM and the risk propensity and trait craving measures (see Table 9).

Table 9

*Pearson Correlations Between HARM Subscales, Risk Battery and Craving*

<table>
<thead>
<tr>
<th></th>
<th>Sober Scale</th>
<th></th>
<th>Drinking Scale</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sexual</td>
<td>Injurious</td>
<td>Sexual</td>
<td>Injurious</td>
<td>Motor</td>
</tr>
<tr>
<td>AUDIT</td>
<td>.18</td>
<td>.15</td>
<td>.33*</td>
<td>.20</td>
<td>.29*</td>
</tr>
<tr>
<td>BAS – Fun Seeking</td>
<td>.17</td>
<td>.21*</td>
<td>.17</td>
<td>.18</td>
<td>.14</td>
</tr>
<tr>
<td>BAS – Drive</td>
<td>.12</td>
<td>.07</td>
<td>.11</td>
<td>.14</td>
<td>-.02</td>
</tr>
<tr>
<td>BAS – Reward Response</td>
<td>.02</td>
<td>-.02</td>
<td>.14</td>
<td>.01</td>
<td>-.03</td>
</tr>
<tr>
<td>BIS_{Inhib}</td>
<td>-.05</td>
<td>-.29*</td>
<td>.01</td>
<td>-.12</td>
<td>-.08</td>
</tr>
<tr>
<td>AAAQ – Obs/Com</td>
<td>.11</td>
<td>.05</td>
<td>.14</td>
<td>.20</td>
<td>.27*</td>
</tr>
<tr>
<td>AAAQ – Inc/Ind</td>
<td>-.01</td>
<td>-.03</td>
<td>.09</td>
<td>.08</td>
<td>.15</td>
</tr>
<tr>
<td>AAAQ – Res/Reg</td>
<td>.07</td>
<td>.06</td>
<td>.00</td>
<td>.16</td>
<td>.09</td>
</tr>
<tr>
<td>BSSS</td>
<td>.21*</td>
<td>.18</td>
<td>.19</td>
<td>.19</td>
<td>.07</td>
</tr>
<tr>
<td>BIS -11– Cog Imp</td>
<td>.18</td>
<td>.10</td>
<td>.21*</td>
<td>.25*</td>
<td>.14</td>
</tr>
<tr>
<td>BIS -11 – Motor Imp</td>
<td>.10</td>
<td>.11</td>
<td>.15</td>
<td>.19</td>
<td>.15</td>
</tr>
<tr>
<td>BIS -11– Non-Plan</td>
<td>.11</td>
<td>.07</td>
<td>.18</td>
<td>.20</td>
<td>.21*</td>
</tr>
</tbody>
</table>

*Note.* Correlation coefficients that reached significance (p < .05) are displayed in bold, *p* < .05 following a sequential Bonferroni adjustment; AUDIT = Alcohol Use Disorders Inventory Test; BAS = Behavioral Activation Scale; BIS = Behavioral Inhibition Scale;
AAAQ = Approach and Avoidance of Alcohol Questionnaire; BSSS = Brief Sensation Seeking Scale; BIS-11 = Barratt Impulsivity Scale.

Table 9 demonstrates that HARM was significantly positively correlated with the dispositional risk measures (sensation seeking and Barratt impulsivity scales), and more consistently under drinking circumstances. This supports the prediction (1a) that dispositional risk propensity measures would be positively associated with the HARM subscales. Trait level craving as measured by the AAAQ revealed significant positive associations between intense approach inclinations (Obsessed/Compelled) across all the drinking subscales. Mild approach inclinations (Inclined/Indulgent) were positively associated with motor vehicle risk on the drinking scale only and avoidance (Resolved/Regulated) was positively associated with injurious risk on the drinking scale only. The positive associations between approach and risk propensity were expected, however the positive association between avoidance and risk propensity on the drinking scale means prediction (1b) was only partially supported.

As can be seen in Table 9, the AUDIT significantly correlated positively across all the sober and the drinking subscales. The same was true for BAS – Fun Seeking and the BSSS (except with the motor vehicle subscale). Importantly, a number of associations were stronger for the drinking scale than the sober scale including the AUDIT, the AAAQ – Obs/Com, and the Barratt impulsivity subscales. BAS – Drive and BAS – Reward Response both yielded a single significant positive association with propensity for risky injurious and sexual behaviour respectively under drinking conditions. The BIS showed a strong negative association only with the sober injurious subscale, with negligible associations across the other subscales.

It should be noted that considering correction for the number of correlations, strict levels of significance were not achieved in all cases, so these interpretations can only be
tentative. Without correction a number of these correlations could reach significance due to chance alone.

To address the prediction that risk propensity would be higher under drinking compared to sober circumstances (2), paired samples t-tests were performed for sexual and injurious risk separately. There was a higher likelihood of engaging in risky sexual behaviour when drinking compared to sober circumstances, $t(262) = -18.57, p < .001, d = -.97$, and no difference between the likelihood of engaging in injurious behaviour when drinking compared to sober, $t(262) = .88, p = .38, d = .06$. Therefore prediction (2) was partially supported as propensity for risk was only increased under drinking circumstances for risky sexual but not injurious behaviour.

Next, the comparative propensity for risk taking was explored between the different behavioural subdomains that emerged from the HARM for drinking and sober circumstances separately. A paired samples t-test was performed to compare sexual and injurious risk under sober circumstances, and a one-way ANOVA to compare sexual, injurious and motor vehicle risk under drinking circumstances. There was a significantly lower likelihood of engaging in risky sexual behaviour than risky injurious behaviour when sober, $t(262) = -2.15, p < .05, d = -.16$. For the drinking risk domains there were significant differences across the three risk behaviours, $F(2,524) = 107.48, p < .001, \eta^2 = .29$. By contrast to the sober ratings, there was a higher likelihood of engaging in risky sexual behaviour than risky injurious behaviour when drinking, $t(262) = 12.05, p < .001, d = .94$. Furthermore, there was a higher likelihood of engaging in risky sexual behaviour than risky motor vehicle behaviour, $t(262) = 11.36, p < .001, d = .87$, and no difference between the propensity to engage in risky injurious or motor vehicle behaviours, $t(262) = -.52, p = .60, d = -.02$. The subscale means and standard deviations for each of the subscales are available in Table 10.
Table 10

Mean and Standard Deviations for Sober and Drinking Subscales

<table>
<thead>
<tr>
<th>Subscale</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sober</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sexual</td>
<td>1.44</td>
<td>.67</td>
</tr>
<tr>
<td>Injurious</td>
<td>1.54</td>
<td>.66</td>
</tr>
<tr>
<td>Drinking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sexual</td>
<td>2.22</td>
<td>.95</td>
</tr>
<tr>
<td>Injurious</td>
<td>1.50</td>
<td>.58</td>
</tr>
<tr>
<td>Motor Vehicle</td>
<td>1.53</td>
<td>.66</td>
</tr>
</tbody>
</table>

To test prediction (3a) that males would report a higher propensity for risk than females, Table 11 reports independent samples t-tests for each of the HARM composite scores.

Table 11

Descriptive Statistics and Independent Samples T-tests Comparing Males and Females across Sober and Drinking Subscales

<table>
<thead>
<tr>
<th>Subscale</th>
<th>Males</th>
<th>Females</th>
<th>t</th>
<th>p</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sober</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sexual</td>
<td>1.72</td>
<td>.84</td>
<td>1.24</td>
<td>.42</td>
<td>6.13</td>
</tr>
<tr>
<td>Injurious</td>
<td>1.76</td>
<td>.77</td>
<td>1.38</td>
<td>.51</td>
<td>4.81</td>
</tr>
<tr>
<td>Drinking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sexual</td>
<td>2.54</td>
<td>.99</td>
<td>2.00</td>
<td>.85</td>
<td>4.74</td>
</tr>
<tr>
<td>Injurious</td>
<td>1.64</td>
<td>.68</td>
<td>1.41</td>
<td>.47</td>
<td>3.29</td>
</tr>
<tr>
<td>Motor Vehicle</td>
<td>1.69</td>
<td>.77</td>
<td>1.41</td>
<td>.54</td>
<td>3.52</td>
</tr>
</tbody>
</table>

Note. N_{males} = 108, N_{females} = 155
As can be seen in Table 11, males report a higher propensity for all risky behaviours under drinking and sober circumstances, supporting prediction (3a).

Finally, to test prediction (3b) that risk propensity would be increased in those categorised with elevated alcohol misuse scores, the AUDIT was used to determine two comparison groups based on published guidelines (detailed in Chapter 3, page 50) that represent low risk and high risk (risky to very risky) drinkers.

Table 12

*Descriptive Statistics and Independent Samples T-tests Comparing Low and High Risk AUDIT Groups across Sober and Drinking Subscales*

<table>
<thead>
<tr>
<th>Subscale</th>
<th>Low Risk</th>
<th>High Risk</th>
<th>t</th>
<th>p</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Sober</td>
<td></td>
<td>1.31</td>
<td>.58</td>
<td>1.53</td>
<td>.71</td>
</tr>
<tr>
<td>Sexual</td>
<td></td>
<td>1.47</td>
<td>.62</td>
<td>1.59</td>
<td>.68</td>
</tr>
<tr>
<td>Injurious</td>
<td></td>
<td>1.37</td>
<td>.49</td>
<td>1.60</td>
<td>.62</td>
</tr>
<tr>
<td>Motor Vehicle</td>
<td></td>
<td>1.36</td>
<td>.52</td>
<td>1.65</td>
<td>.72</td>
</tr>
</tbody>
</table>

*Note. N_{low} = 110, N_{high} = 153*

As shown in Table 12, low risk drinkers had a significantly lower propensity to engage in risky sexual behaviour when sober and across all behavioural subdomains when drinking compared to high risk drinkers. This supports prediction (3b) and provides further evidence for the validity of HARM as a suitable measure to estimate risk propensity for alcohol-related risky behaviour.
Discussion

Alcohol-related risk measures, to date, have relied on self-reported historical precedents of behaviour to estimate present and prospective risk propensity. A hypothetical self-report measure capable of assessing current and prospective alcohol-related risk taking had not yet been developed. The present study was designed to develop and provide initial validation for such a measure, through the use of hypothetical scenarios representing drinking and non-drinking circumstances to estimate alcohol-related risk propensity across multiple behavioural domains. An EFA suggested a scale comprised of two common risky behavioural domains (sexual and injurious) relevant to a young adult population, across both drinking and non-drinking circumstances. A third behavioural domain related to motor vehicle risk under drinking circumstances only, was also suggested by the EFA. A subsequent CFA confirmed the factorial validity of these scales through good model fits. Importantly, these emergent risky behavioural domains were positively associated with other well-validated dispositional risk measures, and indicated increased risk propensity for alcohol consumption circumstances compared to sober circumstances; males compared to females; and high risk drinkers compared low risk drinkers. These findings demonstrate that the HARM may have utility for examining the relative influence of alcohol use on risky behaviour, and the relative likelihood of the occurrence of specific risk behaviours during alcohol consumption episodes.

A primary aim of the present study was to psychometrically evaluate the new HARM items and determine appropriate behavioural domain subscales. An EFA and a CFA both supported the construct validity of a 10-item measure suitable for assessing sexual and injurious risky behaviours across drinking and non-drinking circumstances, and motor vehicle risk for drinking circumstances only. These risky behavioural domains emerged as the most relevant in terms of supporting stable factor solutions.
The sober scale initially yielded a stable ‘legal’ risk factor, but this was discarded because a stable equivalent could not be established on the drinking scale and only comparable scales were considered useful as part of the final measure. Items related to other potential behavioural domains (social/ethical and financial risk) did not yield distinct loading clusters in the EFA, and could not be redistributed to the other stable factors because of unclear loading patterns or conceptual mismatches. The emergence of a common sexual and injurious risk scale is consistent with evidence that these behaviours are elevated in young adult populations (Blum & Nelson-Mmari, 2004; Hingson et al., 2003; Simons, Maisto, & Wray, 2010). Furthermore, alcohol-related motor vehicle risk has also been reported as prevalent in similar samples (Gardner & Steinberg, 2005; Rhodes & Pivik, 2011).

Consistent with the second aim of the present study, it was predicted that the HARM subscales would positively correlate with concurrently measured risk propensity scales (1a). This was supported by a significant positive corrected correlation observed between sensation seeking (BSSS) and the Sober Injurious scale as well as significant corrected positive correlations between the BIS-11 Cognitive Impulsivity scale and the HARM Drinking Sexual and Injurious subscales. The lack of a significant correlation between sensation seeking and the Motor Vehicle risk scale could be attributable to the social stigma and harsh legal/financial consequences associated with drink driving in Australia, thus rendering it less acceptable for pursuing risk-orientated arousal. To further explore this possibility, it may be beneficial in future to examine the sensation seeking subscales that differentiate socially acceptable and unacceptable forms of sensation seeking. The lack of associations between the sober risk behaviours and the BIS-11 suggests that impulsivity may be more transient, and potentially activated by the consumption of alcohol. Sensation seeking on the other hand, is argued to biologically based (Bardo et al., 1996; Zuckerman, 1979) and thus exists as a more enduring trait.
which is relevant even without alcohol activation. Validation of the HARM was further complimented by its positive associations between reward sensitivity (BAS), primarily the Fun-Seeking subscale.

As a supplementary analysis, the AUDIT yielded significant corrected positive correlations with both the Drinking Sexual and Motor Vehicle subscales of the HARM. Moreover, the strength of the relationships between the sexual and injurious risk scales and the AUDIT were respectively 45% and 25%, larger under drinking circumstances compared to non-drinking circumstances. This shows further support for the utility of the HARM as it appears sensitive to variations in alcohol misuse and perceptions of risky behavioural consequences.

Consistent with previous findings of this thesis, the HARM was anticipated to positively correlate with approach of alcohol and negatively correlate with avoidance of alcohol (1b). This prediction was supported for the drinking scales, and only for the relationship between the HARM and intense approach inclinations following correction for multiple associations. Interestingly, the strength of the association between intense approach increased by a proportion of 30% from sexual to injurious risk, and a further 26% from injurious to motor vehicle risk. This arguably suggests that intense craving inclinations become increasingly relevant when the severity of the risk increases (e.g., sex with a casual partner might be construed as less serious than a broken leg, which might be construed as less serious than a traffic accident involving one’s own or others’ fatalities). Essentially, the results suggest that the experience of a generally strong inclination for alcohol is accompanied by an increased propensity to operate a motor vehicle under the influence, more so than for injurious or sexual risk. Mild approach inclinations were also positively associated with motor vehicle risk but nothing else, whereas avoidance was only significantly positively associated with injurious
behaviours when drinking. It was expected that an avoidance of alcohol would be negatively correlated with risk taking, consistent with Study 3. However, it is not clear why state-based avoidance would yield a positive correlation with risk, as was seen in the present findings.

Prediction (2) was also partially supported as only the propensity for risky sexual, but not injurious, behaviour under drinking circumstances was shown to be increased compared to sober circumstances. This suggests that alcohol use may be particularly problematic for behaviours related to sexual consequences as compared to other risky domains. This is consistent with a wide body of research suggesting that risky sexual behaviour is the primary behaviour of concern following alcohol use in young adult populations (J. L. Brown & Vanable, 2007; Cho & Span, 2010; Desiderato & Crawford, 1995; Halpern-Felsher, Millstein, & Ellen, 1996; Simons et al., 2010). This finding may be explained by the notion that alcohol use is actually used to facilitate or enhance sexual activity (Cho & Span, 2010). That is, sexual activity is an intentional outcome which is established prior to the use of alcohol. The psychoactive effects of alcohol itself (impaired inhibition) can then lead to adverse consequences because appropriate actions (e.g., condom use) are disregarded (Halpern-Felsher et al., 1996). This contrasts to injurious activities which are performed during or following alcohol use, because it is unlikely that an individual would actively plan a potential injury as opposed to a sexual experience. In fact, potentially injurious activities might actually be more likely to be avoided when alcohol is consumed. This argument was supported by the significantly greater propensity to engage in risky sexual behaviour, rather than either injurious or motor vehicle risk, under drinking circumstances. The role of reward sensitivity may underlie this distinction between sexual and other risk behaviours, because there is an inherent incentive associated with sexual activities but not painful or physically damaging activities (such as jumping off a balcony or driving a
car while drunk). This argument is perhaps further supported by the positive significant correlation between BAS – Reward Responsiveness and risky sexual, but not injurious, behaviour when drinking.

Prediction (3a) anticipated that, consistent with previous literature (Arnett, 1996; Byrnes et al., 1999; Duangpatra et al., 2009; Jessor et al., 1997), males would indicate higher risk propensity than females. This was supported across all the risky behaviours under both drinking and sober circumstances. Interestingly, the effect sizes were largest for the risky sexual behaviours suggesting again that this risk domain is particularly problematic in young adult drinkers. Findings by Murphy, Monahan, and Miller (1998) have shown that the ingestion of alcohol by females is associated with reduced estimation of sexual risk, but increased perception of relationship potential. This is consistent with research which has shown that females view the risky sexual outcomes of alcohol use as attributable to expectancy effects of alcohol (Davis et al., 2010; Stappenbeck et al., 2013), whereas for males, it may more attributable to the pharmacological effects of alcohol (MacDonald, MacDonald, Zanna, & Fong, 2000). The emergence of sexual risk as a primary risky behavioural outcome in the present sample is consistent with existing literature and further supports the validity of the HARM as a risk assessment tool.

Prediction (3b) anticipated group differences for high and low risk drinkers as determined by the AUDIT. Consistent with previous literature (Papachristou et al., 2012; Petry, 2001; Vuchinich & Simpson, 1998), it was found that high risk drinkers were characterised by an increased risk propensity compared to low risk drinkers, and this was significant for all subscales except the sober injurious scale. Importantly, the effect sizes for the risky sexual and injurious behaviours under drinking circumstances were more than double the effect sizes of the differences on the respective sober scales.
This suggests that alcohol consumption exacerbates the propensity for risky behaviour in high risk drinkers more than it does for low risk drinkers. Further support for the perceived effect of alcohol use on risk propensity was indicated by a significant difference in each group, separately, between risky sexual behaviour when drinking compared to when sober (both \( p < .001 \)) with the effect size for high risk drinkers (\( d = -1.14 \)) being 30% larger than the effect size for low risk drinkers (\( d = -.80 \)). There was, however, no difference between the propensities for drinking and sober risky injurious behaviour for either group. These findings again illustrate that risky sexual behaviour poses the largest threat for young adults following alcohol use, regardless of whether they are a low or high risk drinker.

**Theoretical and Practical Considerations**

In line with existing literature, sexual behaviour emerged in the present data as the most problematic form of risky behaviour following alcohol use. While risky sexual behaviour has been defined as any activity that increases the likelihood of contracting a sexually transmitted infection (STI) (Deckman & DeWall, 2011), some have argued that it may also encompass behaviours that threaten monogamous relationships, current employment or reputation (Deckman & DeWall, 2011). The present study included initial items that evaluated both of these types of sexual behaviour consequences and according to the results of the factor analyses, scenarios that threaten monogamous relationships did not load onto the same factor as items related to the potential for STI or pregnancy-and thus were discarded. Therefore, sexual behaviours that result in potential health consequences (versus social or ethical consequences) may be perceived as fundamentally different types of sexual risk, and may have to be assessed as subconstructs of risky sexual behaviour or as part of another risk domain, such as social or ethical risk.
The present study has offered preliminary estimates of validity and reliability for the HARM, a self-report measure that possesses the unique ability to determine the relative propensity of different risk behaviours often encountered when drinking and the extent those propensities are elevated compared to non-drinking circumstances. Using hypothetical scenarios, this method of assessment requires very little resource to administer to a large sample and has few ethical constraints. This bears an advantage over traditional behavioural risk measures which typically need to be administered in a laboratory and involve complex stimuli.

Limitations and Future Direction

While the application of a hypothetical measure has been argued to address some of the limitations of historical measures, and is easier to administer than behavioural ones, there are some considerations that should be taken into account when interpreting the HARM.

Firstly, there is an assumption that individuals completing the measure have accurate insight into their own inebriated mindsets. Evidence suggests that risk intentions are influenced by alcohol intoxication (e.g., Davis, Hendershot, George, Norris, & Heiman, 2007), which may render non-intoxicated ratings of intentions in alcohol-related circumstances less valid. However, to some extent, it can be assumed that participants’ HARM ratings are based on a combination of present disposition and, to some extent, historical precedents of risky behaviour, which may serve to improve the validity of the hypothetical measure over measures that rely on historical precedents alone. The HARM would need to be rated under experimental conditions of alcohol intoxication and sobriety in order to determine if sober ‘drinking’ ratings are valid estimates of actual alcohol intoxicated ratings. In addition, the current response primer of “when dinking” may suggest different levels of intoxication to different respondents.
Furthermore, the response options were not counterbalanced which may introduce order effects. Future administrations may need to use more explicit and counterbalanced descriptive primers to disambiguate dosage perceptions, thereby reducing extraneous variability in responses.

Secondly, to further explore the validity of the HARM, it needs to be evaluated alongside a historical risk measure that captures behavioural instances relevant to the hypothetical ones proposed. This will not only provide additional evidence for the validity of the measure but also allow the estimation of the relative frequency of the hypothetical behaviours in a given population. If these behaviours are not commonly engaged in, it could explain the constrained variance of the HARM responses observed in the present study, as well as the modest correlational effect sizes observed.

Thirdly, the awareness of socially acceptable behaviours, and the intention to conform to such conventions, may reduce the accuracy of ratings (i.e., potential social desirability effects). In ‘emerging adults’, alcohol-based risky behaviour is often considered socially acceptable amongst peers and even lauded. It may be necessary to concurrently administer a socially desirable responding scale (e.g., Paulhus, 1984) as well as items that gauge the social perception of alcohol fuelled risky behaviour to control for any variance shared with these constructs and the HARM. Nevertheless, the individual online anonymous administration of the HARM used in the present study likely reduced the potential effects of social desirability or population-based social acceptability effects. Future research should investigate the perception of risky behaviour following alcohol consumption in terms of its social acceptability across varying age groups, as this may have an important moderating effect on the propensity to engage in alcohol-related risky behaviour. This may also be useful for informing and evaluating the effect of public health messages. Following from this, the HARM needs
to be cross-validated in a less homogeneous sample, particularly given the restricted range of the responses observed in the present study. While the use of a young adult sample increases the likelihood of capturing increased risk propensity, validity for the HARM can also be demonstrated by showing that risk propensity is lower in samples characterized by an older demographic, as well as by higher levels of education and less ethnic diversity (Duangpatra et al., 2009; Lejuez et al., 2002). Furthermore, the specific risk domains suggested by the current study can be confirmed, as well as exploring the possibility of other relevant domains.

Finally, while the final sober and drinking scales were comprised of common sexual and injurious based risk assessments, the EFA suggested that other risk domains may be relevant for young adult populations. Specifically, legal risk emerged as a stable factor for the sober scale only which suggests that it may be important, but not necessarily for alcohol-related circumstances. Given that some traditional alcohol and general risk measures include domains that are relevant to ethical/social risk (Hurlbut & Sher, 1992; Nicholson et al., 2005; Weber et al., 2002) indicates they may be worth further consideration through additional item generation. The initial item pool for the HARM was relatively limited at 17 items for the scenarios shared across sober and drinking circumstances. As a result, some of the potential risk domains that did not emerge as stable factors (resulting from ethical, social or financial risk items) may not have had a sufficient quantity of related items or they were not suitably representative of the targeted risk domain due to wording or relevance of the scenario to young adults. However, the pursuit of an ethical/social risk domain through further investigation may be contaminated by the conceptual overlap with the risk factors that emerged in the present study. That is, the sexual, injurious and motor vehicle risk behaviours may share fundamentally similar consequences because the outcomes of those behaviours could also have ethical or social implications (engaging in sexual activity outside of a
committed relationship or injuring a significant other in a motor vehicle accident). Furthermore, the relevance of specific risk domains may be population-dependent which would require a cross-validation to establish.

Given that the HARM yielded relatively low reliability estimates and the correlations with other validated-measures were of modest strength, further scale development is warranted to improve its psychometric properties. This will require the generation of new risk items, or potentially rephrasing some of those that were discarded during the factor analyses, to assist in capturing a suitable breadth of behavioural risk domains that are represented by stable factors.

This study was the first step in developing a hypothetical alcohol risk measure which has preliminary utility for assessing current and dispositional risk. Sexual risk taking, particularly in males and high risk drinkers, emerged as a considerable area of concern with regard to alcohol-related risk propensity. Several considerations have been identified which need to be addressed in subsequent data collections, such as the validity of sober ‘drinking’ ratings, cross-validation in a less homogenous sample, relevant risk domain confirmation or exploration, and increasing the number of items in the scale. As a result, the HARM may be further refined for the benefit of improving its ability to explore alcohol use and risky behaviour.
CHAPTER 7:

General Discussion
Alcohol is the most commonly used licit drug amongst Australian adolescents (AIHW, 2011; V. White & Bariola, 2012) and is ranked globally as the eighth leading risk factor for death, and third for disease and disability (WHO, 2011). This thesis investigated the motivational states that lead to maladaptive alcohol use, and the subsequent behavioural outcomes of these motivational states, in several samples of young Australian adults. This was achieved through a combination of novel experimental methodologies, and the development of new psychometric assessments, utilized across three distinct phases of study.

Firstly, by drawing upon the Ambivalence Model of Alcohol Craving (Breiner et al., 1999), opposing inclinational dimensions of approach and avoidance were assessed to characterize craving profiles in response to alcohol cues. Secondly, these inclinations were then evaluated prior to behavioural decision-making performance to determine if there was a link between craving and risk taking. Initially, this was explored using traditional decision-making tasks then followed by a modified task that offered increased salience toward alcohol. Finally, an alternative self-report method of risk assessment was developed as a way to examine risk taking as a result of alcohol use. This sequence of studies was designed to address the following questions: how is alcohol craving best conceptualised and measured? Does craving influence the decision-making of users, and, if so, does this link between alcohol craving and decision-making manifest differently in groups with different alcohol use histories? Are presently available laboratory measures capable of capturing alcohol orientated risk taking, and if not, what improvements/modifications could be made? Finally, should self-report alternatives be developed to compliment behavioural tasks for alcohol-orientated risk assessment?
Phase 1: Development of a Craving Induction and Measurement Procedure

Prior to examining the influence of alcohol craving on risky decision-making, a craving manipulation paradigm needed to be developed and evaluated. This allowed the first question of this thesis to be addressed, namely, how craving should best be conceptualised and measured. Specifically, a suitable measure for assessing craving needed to be validated for tracking state inclinations over a short time period. The craving induction developed utilized a combination of visual and audio alcohol cues as well as the anticipation for alcohol consumption; this was tailored for a range of alcoholic beverages. While the measurement of craving in the literature has predominantly been unidimensional (e.g., Anton & Drobes, 1998; Coffey et al., 1999; Coffey et al., 2006; Rosenberg, 2009), the present study adopted a dual dimensional measurement strategy to account for the mitigating influence of a concurrent inclination not to consume alcohol (i.e., avoidance). This conceptualisation is consistent with cognitive attentional frameworks (Field & Cox, 2008; Field et al., 2009) and neurobiological models of reward seeking (Anton, 1999; Robinson & Berridge, 1993). Therefore two single-item scales, one for approach and one for avoidance, were considered appropriate for assessing alcohol craving dimensions pre- and post-cue exposure.

Study 1

Inconsistent with the argument that alcohol craving can be adequately measured by assessing an approach strength alone (e.g., Kavanagh et al., 2013), the results of Study 1 demonstrated that opposing avoidance inclinations can change concurrently to approach over the course of a craving induction. The changes in avoidance mitigated the relative net strength of the approach inclination. Specifically, both low and high risk drinking groups increased similarly in approach but the avoidance inclination decreased only in the high risk group, resulting in different craving profiles. Thus, differences in
the risk group craving profiles only emerged only when taking into account the simultaneous changes in the relative strength of the avoidance. By examining the relative balance of craving dimensions (approach minus avoidance), it became clear that high risk drinkers shift from a state of dominant avoidance prior to alcohol cue exposure, to one of dominant approach following alcohol cue exposure. Low risk drinkers similarly shift in the same direction for approach, but remained tempered by their stronger avoidance inclination. By calculating the relative balance, it was possible to more clearly determine the relative effect that avoidance has on approach. In particular, baseline avoidance was shown to be of considerable importance when observing changes in the relative balance. This is because low baseline avoidance strengthened, or did not impede, increases in the approach inclination; whereas high baseline avoidance appeared to weaken and counteract increases in the approach inclination. The imbalanced craving profile exhibited by high risk drinkers, and the balanced profile exhibited by low risk drinkers in Study 1, is consistent with evidence from an implicit measurement paradigm where avoidance differentiated alcohol dependent individuals versus controls, despite similar levels of approach (Dickson et al., 2013). That is, alcohol dependent individuals were characterised by weaker avoidance compared to controls. Because of the similar findings for high risk drinkers and alcohol dependent individuals, the detection of low avoidance in the former group may have practical importance in preventing the progression to an alcohol use disorder. Lower levels of explicit avoidance in high risk and clinical drinking groups respectively suggest that more effort would be required to resist increases in approach when compared to low risk drinkers, who already possess a ‘protective brake’ in their elevated avoidance inclinations. This ‘protective brake’ in low risk drinkers is consistent with reports that alcohol dependent individuals, who are characterised as current abstainers, exhibit higher levels of avoidance relative to approach (Stritzke et al., 2007).
The exploration of both craving inclinations in this thesis has important implications for treatment. Specifically, a failure to acknowledge the presence of avoidance can mislead the assessment of the motivational profile of any given individual, and their subsequent consumption behaviour, as initially explored in Study 2.

**Study 2**

Study 2 extended upon Study 1 in two critical ways. Firstly, a non-alcohol control condition was included to confirm that changes in approach and avoidance were unique to an alcohol cue exposure condition. Secondly, a measure of ad libitum alcohol consumption was administered following the craving induction. This allowed further assessment of the effectiveness of the craving induction as well as the external validity of approach and avoidance measurements for predicting subsequent alcohol consumption behaviour.

Again, approach increased for both low and high risk groups following exposure to alcohol cues. However the pattern of avoidance in Study 2 differed from that found in Study 1 as it decreased for both groups, rather than just the high risk group. Also, the strength of the decrease effect was stronger for the high risk group. Examination of the relative balance difference scores revealed that while avoidance decreased for low risk drinkers, its elevated level at baseline (relative to approach) meant that, similar to Study 1, a relatively equal balance between approach and avoidance was observed following cue exposure. Therefore, low risk drinkers were not characterised by a dominant approach inclination post-alcohol cue exposure. By contrast, high risk drinkers exhibited a smaller avoidance inclination at baseline relative to low risk drinkers. Therefore, the significant shift toward approach, post-alcohol cue exposure, resulted in a significantly dominant approach relative to avoidance profile.
Importantly, the non-alcohol cue exposure condition, while showing a significant increase in approach and decrease in avoidance following control cues, was characterised by substantially smaller effect sizes than those in the alcohol condition. Furthermore, examination of the relative balance of craving between approach and avoidance in this condition revealed that approach inclinations for both risk groups in the non-alcohol condition were more strongly balanced by avoidance throughout the entire laboratory session. This indicates that those who were not exposed to alcohol could be clearly distinguished from those who were by conceptualising their craving profiles in terms of relative strength of approach and avoidance.

Given that any sound theoretical conceptualization of alcohol craving lies in its ability to predict drinking (Kavanagh et al., 2013), Study 2 also explored the relationship between approach and avoidance and beer consumption on a laboratory taste test. Importantly, both approach and avoidance were significant predictors of beer volume consumed (ml) in high risk drinkers only. Furthermore, the relative balance score was a significant predictor of alcohol consumption in the alcohol condition. The proportion of beer consumed in the taste test, relative to total fluid, was higher in the alcohol cue exposure condition compared to the non-alcohol cue exposure condition. These findings are consistent with studies that have found positive associations between approach inclinations and ad libitum drinking (Leeman et al., 2009) as well reduced ad libitum drinking when trained to avoid alcohol compared to attending to alcohol (Field & Eastwood, 2005).

The utility of the relative balance interpretation of motivational craving profiles, and its relationship with drinking outcomes found in this thesis, is consistent with studies that have explored imbalanced craving profiles in clinical groups. For example, Stritzke et al. (2007) found that high approach and low avoidance was associated with a
high risk of lapsing in alcohol dependents, and Schlauch et al. (2013b) found that high avoidance and low approach decreased drinking over time in those with an alcohol use disorder.

Study 2 has made a novel contribution to these findings by showing that critical differences between risk groups can also be revealed through *acute and dynamic* shifts in the relative strength and subsequent balance or imbalance between the two competing craving inclinations. Furthermore, the unique relevance of avoidance can only be determined when it is measured across a range of specific situations and groups (i.e., low and high risk, alcohol and non-alcohol cue exposure). A failure to acknowledge avoidance can result in methodologies that do not detect its potentially complex associations across unique circumstances. The independent nature of the avoidance patterns revealed in Studies 1 and 2 strongly suggest that a complete understanding of an individual’s motivational craving state can be better captured when avoidance is also measured. Furthermore, examining avoidance as part of a relative balance score appears to also have additional utility in differentiating craving profiles in social drinkers.

In the context of alcohol use disorders, if avoidance is not measured alongside approach then researchers may fail to detect and quantify the potential ambivalence experienced by individuals who exhibit moderate to high inclinations of both dimensions. This would mean a distinctly different motivational profile to an individual with moderate to high approach and low avoidance or an individual with moderate to high avoidance and low approach. The exact nature of the relative balance between the two dimensions may be a critical factor for subsequent drinking behaviour and treatment readiness and engagement (DiClemente et al., 2004; W. R. Miller & Tonigan, 1996).
Phase 1 Summary and Future Direction

Studies 1 and 2 showed that low risk drinkers possess an elevated baseline avoidance buffer, which appears to offer an increased likelihood of maintaining a balanced craving profile even when experiencing similar increases in approach as high risk drinkers. These findings strongly suggest that research should focus on developing strategies to strengthen this protective factor in vulnerable individuals. By providing a safety net of avoidance, as was observed in low risk drinkers, an increased resistance for dominant approach profiles may be afforded when encountering alcohol cues. Subsequently, maladaptive alcohol use patterns might be reduced and treatment engagement increased. In cases where problem drinkers are in the recovery stage from dependence, heightened state avoidance would be required to offset the approach response to alcoholic stimuli (McEvoy et al., 2004).

Studies 1 and 2 have provided further support for the validity of the Ambivalence Model as a means to assess alcohol craving and its relationship with subsequent consumption behaviour. Therefore, the first question of this thesis has been addressed, with the Ambivalence Model of craving shown to be a useful conceptualisation for measuring alcohol craving in response to alcohol cue exposure. Its utility over traditional unidimensional methods was evidenced by avoidance yielding a dissociable pattern of change to approach, and explaining significant variation in actual drinking behaviour. That is, changes in avoidance differentiated the dominant avoidance, relative to approach, craving profile of low risk drinkers to the dominant approach, relative to avoidance, craving profile of high risk drinkers, which could not have been detected if only measuring approach.

Moreover, the first two studies of this thesis supported the effectiveness of the alcohol induction procedure for successfully eliciting a craving response, as well as showing that approach and avoidance explain significant variance in beer consumption.
A particular strength of this procedure was the use of flavoured beverages as control stimuli in the induction procedure of Study 2, which meant that similar sensory properties were experienced in the non-alcohol condition to the alcohol condition. Control stimuli that possesses a distinct colour, taste or aroma are arguably a more comparable and externally valid control stimulus than water (Stritzke et al., 2004). Demonstrating that these materials would elicit differential craving outcomes was essential before subsequently examining the potential influence of craving on decision-making performance, which was addressed in Studies 3 and 4. Future investigation should further explore the effectiveness of the craving induction and the validity of the measurement procedure in a clinical sample to show that craving profiles are distinctly different to those observed in social drinkers. Evidence suggests that they would be characterised by more intense approach ratings and increased variability in avoidance (Stritzke et al., 2007). Ideally a more heterogeneous community sample could also be sought to determine which craving profiles are a representative benchmark for the Australian adult population.

Phase 2: Alcohol Craving and Decision-Making

The recent inclusion of craving in the DSM-5 as a key symptom of substance use disorders (American Psychiatric Association, 2013) highlights the recognition of its potential influence on productivity and functional indices. This relates to the second question of this thesis, namely, whether craving influences the decision-making of users, and, if so, whether this link between alcohol craving and decision-making manifests differently in groups with different alcohol use histories. To address this question, the findings of Studies 1 and 2 were extended in Studies 3 and 4 to explore the relationship between approach and avoidance inclinations toward alcohol and risky decision-making. The premise for this relationship is underpinned by the effect that repeated and sustained exposure to alcohol has on neural pathways and cortical
structures, such as the amygdala and frontal lobe circuitry. These areas are also involved in decision-making and reward processing (Crews & Nixon, 2008; Fein et al., 2002; Fortuna & Smelson, 2008; Hartstra et al., 2010; Hsu et al., 2005; Sullivan & Pfefferbaum, 2005), as well as craving for a range of substances (e.g., Childress et al., 1999; Grant et al., 1996; Myrick et al., 2004; Park et al., 2010). Approach and avoidance in the context of alcohol craving represent reward seeking and withdrawal inclinations, which can be respectively likened to the competing influences of impulsive and inhibitive processes in risky decision-making behaviour. Essentially, once craving has manifested then imbalanced response profiles (i.e., high approach, low avoidance) may trigger maladaptive alcohol use.

Study 3 examined the performance of high and low risk drinkers on traditional laboratory decision-making measures following an alcohol craving induction, to determine if there were any differences between the risk groups and whether there would be a relationship between approach and avoidance inclinations and risky behaviour. Study 4 extended on this procedure by modifying the decision-making task stimuli to increase its relevance to alcohol use. Enhancing the salience of the task and making it congruent with the craving induction stimuli was expected to increase the strength of relationship between craving and risk taking. Importantly, the external validity of the new task was explored through its relationship with beer consumption in the taste test.

**Study 3**

The results of Study 3 indicated that decision-making performance on the Balloon Analogue Risk Task (BART) and Iowa Gambling Task (IGT) was not impaired due to alcohol craving, or in high risk drinkers compared to low risk drinkers. This is inconsistent with studies that have found differences in BART performance as a result
of mood induction (Cyders et al., 2010; Lighthall et al., 2009; Maner et al., 2007), but consistent with studies that have also not found performance differences between high and low risk groups on behavioural impulsivity measures (Papachristou et al., 2012). However, the unique methodology for craving measurement in this thesis provided some interesting correlations between approach and avoidance inclinations with risk-taking performance on the BART in each risk group. Specifically, approach was strongly positively correlated with risk taking pre- and post-alcohol cue exposure in high risk drinkers. This suggests that risk taking increases when approach inclinations are elevated, regardless of whether exposure to alcohol has occurred. By contrast, the avoidance inclination in low risk drinkers exhibited a strong negative correlation with risk taking at baseline which dissipated following alcohol cue exposure. This suggested that avoidance offers a protective mechanism in low risk drinkers for reducing risk taking. However, the effectiveness of this protective mechanism may be lessened when alcohol cue exposure occurs.

These findings highlight the value of measuring avoidance with respect to subsequent behaviour, given that the evidence from Study 3 suggests that avoidance plays a potentially influential role in dampening risk-taking behaviour. Consistent with the interpretation of the motivational craving profiles in Studies 1 and 2, high risk drinkers are characterised by a dominant approach inclination that appears to correspond to increased risk-taking behaviour. This may result from a failure of inhibitory functions (characterised by a low avoidance inclination) to ‘override’ impulsive approach-orientated responses (Bechara, 2005; Noël et al., 2010). This means that self-regulation of subsequent behaviour may be more difficult for high risk drinkers. Conversely, low risk drinkers demonstrate a strong negative baseline relationship between avoidance and risk taking, suggesting that inhibitory functions are
able to adequately regulate impulsivity when faced with an approach-orientated craving response.

The demonstrated link between approach and avoidance dimensions and risk-taking behaviour in Study 3 could have important implications for the treatment of alcohol use disorders. For example, tracking avoidance may be a useful way to monitor the effectiveness of treatments that are designed to reduce maladaptive alcohol use, by increasing the strength of avoidance inclinations and decreasing the strength of approach inclinations.

The lack of performance differences between the risk groups in Study 3 suggest that cue exposure and subsequent increases in craving alone may not be sufficient to interfere with increased inhibition for decision-making in a task unrelated to alcohol use. These findings partly answered the third question of this thesis, which was whether presently available laboratory measures were capable of capturing alcohol-orientated risk taking, and if not, what improvements/modifications could be made. Since the BART and IGT did not convincingly capture alcohol-orientated risk taking, the methodology of Study 4 was designed to increase the likelihood of detecting an effect of craving on decision-making in two ways. Firstly, the strength of the craving manipulation was bolstered with the ingestion of beer prior to decision-making, and secondly, the decision-making task, the Drinking Analogue Risk Task (DART), now simulated beer consumption which more closely aligned the induction procedure to the behavioural assessment. Additionally, a non-alcohol cue exposure condition was included to determine if decision-making performance decrements were specific to exposure to alcohol compared to non-alcohol cues.
Study 4

Study 4 results revealed that DART performance was positively related to beer consumption, which supports its utility in capturing alcohol-orientated behaviour. Similar to Study 3, there were no risk group differences on this task in the alcohol condition, and there were no performance differences between the exposure conditions. While this is inconsistent with studies that have found performance differences on alcohol-related inhibition and delayed discounting tasks (Field et al., 2007; MacKillop & Murphy, 2007; Noël et al., 2007; Rose & Duka, 2008), it suggests consistency with neurobiological accounts which posit that long term alcohol use would be necessary to result in acute effects of alcohol exposure on executive function (Anton, 1999; Jentsch & Taylor, 1999; Robinson & Berridge, 1993), and therefore may not be readily observable in relatively young social drinkers.

However, the direction of the associations observed in Study 4 between approach and avoidance and the DART were the same as the associations between approach and avoidance and the BART in Study 3. Specifically, in Study 4, approach was strongly positively associated with risk taking in high risk drinkers following alcohol cue exposure, but not at baseline which was the case in Study 3. The negative association between avoidance and risk taking in Study 4 was not significant in low risk drinkers as it was in Study 3 which indicated that, for this risk group, avoidance may not be as relevant when faced with alcohol stimuli. It was however, shown in both Study 3 and 4 that low risk drinkers experienced elevated avoidance relative to approach throughout the craving induction and the decision-making tasks. This, coupled with the significant negative relationship between avoidance and risk taking on the BART in Study 3, suggests that avoidance plays a role in the regulation of risk taking behaviour for low risk drinkers.
In general, the effect sizes were weaker in Study 4 compared to Study 3. Despite the enhancement of the craving manipulation with the taste test and the implementation of the DART instead of the BART, avoidance, unlike approach, did not emerge with the same significance as was indicated in Study 3. It was identified that limited power was likely responsible for the weaker relationships observed in Study 4, especially given that several of the correlations were marginally non-significant. While the total sample size was larger than Study 3, the inclusion of an additional (non-alcohol) condition reduced the unique group sizes, thus decreasing the likelihood of detecting the expected effects.

In summarising the utility of the BART and DART as suitable measures for capturing variations in decision-making as a result of alcohol use history and acute exposure, there are some promising results from Studies 3 and 4. In particular, the BART is related to both approach and avoidance inclinations and with additional power, the DART would likely also achieve significant correlations with avoidance to complement those found with approach in Study 4. Furthermore, and importantly, the DART was related to actual beer consumption on the taste test in Study 4, supporting the external validity of the task. Notably, the utility of the BART or DART for investigation into the influence of alcohol on decision-making outweighed any potential utility of the IGT, which, traditionally, is a more widely used measure of decision-making. By drawing upon the risk parameters of the BART and the principles of substance-relevant task stimuli implemented in a variety of executive function tasks (e.g., Field et al., 2007; MacKillop & Murphy, 2007; Noël et al., 2007; Rose & Duka, 2008), the development of the DART represents a novel contribution by this thesis to the literature, that may serve to facilitate further research into the influence of alcohol use on decision-making performance.

It is also appropriate to acknowledge the limitations of using the BART or DART to investigate risky decision-making. While the BART and IGT were both
selected to explore the effects of craving on risk-taking behaviour, the literature indicates that these two tasks are unrelated (Aklin et al., 2005; Bishara et al., 2009; Lejuez et al., 2003b), suggesting that they measure different decision-making processes. Furthermore, the completion time of the BART is considerably less than that of the IGT. This, coupled with the suboptimal pumping rates discussed in Chapter 5, meant that exposure to the task was relatively brief. The drawback of this is that the learning component of the BART (the coloured balloons with differing risk schedules) may not have been adequately acknowledged by the participants. Increasing the number of trials may have improved the familiarity with the coloured balloons and the reliability of the task. However, the suboptimal pumping may have negated any benefit of increasing the number of trials because the low pumping rates employed by participants on each trial would also limit their exposure to the varying explosion schedules for each balloon colour. This argument is supported by the findings of the original BART study in which participants reported an unawareness of different coloured contingencies, despite completing more trials (Lejuez et al., 2002). Given that the DART possessed the same characteristics of the BART in terms of the risk schedule, it would be thought to be limited in the same way. In addition, and despite it being related to beer consumption in the taste test, it was not associated with AUDIT scores. This may reduce its applicability for investigating links to broader maladaptive drinking behaviour. Suboptimal pumping (or sipping) could be addressed in future research by offering a variable incentive structure whereby exponentially higher returns are experienced the longer a trial continues.

Despite the potential weaknesses of the BART or DART, the experimental design of the studies examining the effect of alcohol cue exposure on risk taking in different groups and conditions was a considerable strength, as it meant that causal explanations would have been justifiable. Carefully matched materials and standardised
procedures across all participants increased the likelihood of detecting any experimental effects. Furthermore, developing conceptual tasks that pair negative outcomes with simulated alcohol consumption, such as the DART, could have important applications in training alcohol dependent or at-risk drinkers to reduce their consumption. This is an area of innovation that could benefit from further research.

Taking the findings of Studies 3 and 4 together, alcohol craving assessed using single item approach measures yielded consistent positive associations with risk-taking behaviour and most strongly in high risk drinkers. Avoidance inclinations on the other hand presented a more complex pattern of results because of the inconsistencies observed across studies. Essentially, avoidance may be particularly important for risk taking in certain groups and certain situations. For example, the results of Studies 3 and 4 suggest it may offer a dampening effect on general risk taking prior to alcohol cue exposure in low risk drinkers and may be necessary for dampening alcohol-related risk taking following alcohol cue exposure in high risk drinkers. This suggests that avoidance for low risk drinkers provides a baseline protection against an acute craving response when exposed to alcohol, which may offer increased capacity for self-regulation when decision-making. Therefore, the distinctly dominant avoidance profile exhibited by low risk drinkers suggests that they are “inclinationally prepared” for dynamic and rapid changes in craving inclination, thus protecting them against increased subsequent risk taking. By contrast, high risk drinkers are characterised by the presence of a weak avoidance inclination at baseline, leading them to be “inclinationally vulnerable” to dynamic and rapid changes in craving inclination, which increases their likelihood of subsequent risk taking.

The issue of vulnerability to alcohol cues is exacerbated by the relentless commercial atmosphere that Australian and wider societies are typically exposed to.
Marketing strategies for alcohol are specifically designed to impose the reward-orientated characteristics of different beverages onto potential consumers, which can be of considerable concern for those struggling with an alcohol use disorder. Advertisements are not easily avoided in contemporary society and the presentation of a cold refreshing beer after a hard day’s work or an encounter with an attractive person in a club while drinking a spirit can be difficult to ignore. It has been argued that, during alcohol promotion, the alcohol industry has exploited the risk-orientated spontaneity associated with alcohol use that is an accepted norm for young adults (Keane, 2009). Incidental exposure to alcohol cues is an ongoing issue for individuals with ambivalent or high approach/low avoidance profiles. While the studies in this thesis utilized careful and controlled exposure to alcohol cues, exposure in the real world is often encountered in unexpected, uncontrollable, and varying ways. As a result, individuals need to be especially diligent with respect to their attentional processes and be “inclinationally prepared” rather than “inclinationally vulnerable” if a rapid change in craving state is to be averted. This is why attentional training and avoidance enhancement treatments could be critical in the management of an alcohol use disorder in future.

Counterintuitively, this thesis did provide evidence that some alcohol use may be adaptive in the face of increased approach inclinations. When examining the relative balance scores of low risk drinkers in Study 2, it was observed that after the initial increase from dominant avoidance to marginally, but not significantly, dominant approach, they experienced a second shift in direction following the taste test. This shift was back in the dominant avoidance direction and suggests that the consumption of beer may have satiated the elevated approach inclinations. Again this reinforces that the “inclinational preparedness” which characterises the low risk craving profile allows effective self-regulation with regard to alcohol consumption. While a small dose of beer may be useful for alleviating approach inclinations in those with more robust baseline
avoidance and more modest peak approach inclinations, it is unlikely to be effective in
the case of high risk or dependent drinkers. Evidence from Study 4 suggests that for
these groups the opportunity to consume beer maintained the dominant approach
inclination achieved post cue exposure. Drinking beer potentially enhanced the
“inclinational vulnerability” of these individuals, which, outside the laboratory, may
lead to a loss of control during a subsequent drinking episode. That is, low avoidance
coupled with acute alcohol cue exposure is likely to facilitate maladaptive drinking.

**Phase 2 Summary and Future Direction**

Studies 3 and 4 addressed the second and third questions of this thesis: does
craving influence the decision-making ability of users, and, if so, does this link between
alcohol craving and decision-making manifest differently in groups with different
alcohol use histories? Also, are presently available laboratory measures capable of
capturing alcohol orientated risk taking, and what improvements/modifications could be
made?

Findings showed that when experimentally administering decision-making tasks,
alcohol craving does not influence the decision-making ability of users with different
alcohol use histories even when task salience is increased. However, the significant
positive correlations between approach inclinations and risk taking in high risk drinkers
and the negative correlations between avoidance and risk taking in low risk drinkers
observed in Studies 3 and 4 strongly indicate that both dimensions of alcohol craving
may have an effect on decision-making performance. While this was not observable in
the context of an executive impairment in response to acute alcohol cue exposure, it
potentially exists as a broader relationship between opposing inclinations for alcohol
and risk taking in real-world contexts. This relationship may, over time, be strongly
linked to executive impairments. Any study that utilizes a homogenous sample of high-
functioning young adults with relatively short drinking histories will likely struggle to
detect deficits on proxies for real-world risk-taking and executive dysfunctions.
Particularly as such dysfunctions, according to the neurosensitization model (Robinson
& Berridge, 1993), take prolonged and repeated exposure to alcohol to manifest.

However, because the outcomes of risky drinking behaviour present a significant
concern in young adults, the continuing challenge is to develop measures that can
capture alcohol-orientated risk taking in such a sample. The relationship between DART
performance and both craving inclinations, as well as taste test beer consumption in
Study 4, provided some initial support for the utility of the DART as a means to assess
alcohol-orientated risky decision-making. Even though DART performance did not
differentiate high and low risk drinking groups or those in the alcohol or non-alcohol
conditions, there is promise that future investigation with this task in a larger sample
may offer the power necessary to detect group differences. Given that the DART, in
principle, is directly related to drinking related outcomes, performance differences may
also emerge more strongly in a clinical population.

Further investigation was required to address the fourth question of this thesis,
which was to determine whether suitable alternatives to laboratory risk tasks for
capturing alcohol-orientated risk taking should be developed. Traditional tasks such as
the BART and the modified alternative developed in Study 4 have shown some promise
in examining the relationship between responses to alcohol cue exposure and risk-taking
behaviour. However, the implementation of tasks such as the BART and DART are
based on analogue risk assessment, and may not always closely reflect the specific risk-
taking behaviours that can occur as a result of alcohol use. Since it is unethical and
impractical to manipulate real-world risk behaviours such as sexual and injury-based
risk behaviour in the laboratory, self-report measures are a useful alternative to capture
the propensity for these activities. Therefore, Study 5 pursued a new direction in the course of this thesis to develop an alternative risk assessment strategy to that of analogue laboratory tasks, in the form of a self-report for exploring the link between alcohol use and real-world risk-taking behaviour.

**Phase 3: Self-Reported Alcohol-Related Risky Behaviour**

In view of the constraints associated with estimating the propensity for real-world risky behaviour using laboratory decision-making tasks such as the BART and DART, Study 5 developed a simpler method which might be more suitable for assessing present and future dispositions for alcohol-related risk. This addressed the fourth and final question of this thesis, which was whether self-report alternatives should be developed to compliment behavioural tasks for alcohol-orientated risk assessment. As the behavioural measures used thus far had yielded a combination of inconsistent or non-significant patterns of association with alcohol craving, alternative self-report assessment options were considered. As a result, a self-report Hypothetical Alcohol-related Risk Measure (HARM) was developed and validated to (a) address the shortcomings in available alcohol-based risk self-report measures and (b) provide additional utility for investigating the perceived influence of alcohol across different domains of risky behaviour, and circumstances of intoxication and sobriety.

Currently available alcohol risk measures have relied on self-reported historical precedents of behaviour to estimate present and prospective risk propensity. The HARM improves upon this typical methodology by presenting hypothetical scenarios which allow ratings for present or future risk propensity to be collected. This has an advantage over previous measures because it enables participants to be compared across various types of risk scenarios, regardless of whether or not they have encountered them before.
Typically, the relationship between alcohol consumption and risk taking is estimated through global correlation methods (Arnett, 1996; Balodis et al., 2009; Lejuez et al., 2002; Thompson et al., 2005), which only recognises risky behaviour and alcohol consumption separately. Estimates based on this methodology cannot presume that one causes the other because there is no way to determine to what extent they are co-occurring. However, the HARM alleviates this issue by specifically requesting ratings for risky behaviour across both intoxication and sobriety circumstances, so that comparisons of risk propensity can be made.

**Study 5**

Through the exploratory and confirmatory factor analyses in Study 5, several useful risk domains emerged from the HARM. Risky sexual and injurious behaviour were represented across both drinking and non-drinking circumstances, and motor vehicle risk formed a stable factor on the drinking scale only. The ability to compare prospective risk propensity across these specific behavioural domains and across drinking and non-drinking circumstances was a novel contribution provided by this thesis. Furthermore, the emergence of multiple and distinct risk domains is consistent with several existing generalised hypothetical risk measures (e.g., Nicholson et al., 2005; Weber et al., 2002). By using the HARM as an alternative method of risk assessment to the BART and DART, a number of interesting findings were reported.

Firstly, when comparing risk behaviours within *intoxicated* circumstances only, the propensity to engage in risky sexual behaviour was greater than the propensity to engage in injurious or drink-driving behaviour. Conversely, when comparing risk behaviours within *sober* circumstances only, the propensity to engage in risky sexual behaviour was lower than the propensity to engage in injurious behaviour. These findings suggest that when alcohol is consumed, young Australian adults are at a higher
risk of engaging in unprotected or casual sexual activities than sustaining an injury, or operating motor vehicle alone or with occupants. When alcohol is not involved, there is a higher risk of sustaining an injury than engaging in unprotected or casual sexual activities. These findings are the first of this nature because the unique method of the HARM was able capture and compare the propensity for these risk behaviours.

Secondly, when comparing risk behaviours between intoxicated and sober circumstances, propensity for risky sexual behaviour was significantly elevated for drinking circumstances compared to sober circumstances, and there was no difference in the propensity for injurious behaviour between drinking and sober circumstances. These findings suggest that drinking is more problematic for increasing the possibility of negative sexual consequences, such as contracting an STI or unwanted pregnancy, compared to when sober. These findings are consistent with reports that risky sexual behaviour is elevated in young adults with high drinking histories (e.g., Simons et al., 2010; Thompson et al., 2005), are but inconsistent with reports that regular intoxication under the age of 19 is associated with increased risk of sustaining injuries that require medical attention (Hingson et al., 2002). However, evaluation of these results within the context of existing findings is not directly comparable because existing studies do not distinguish between alcohol-related and non-alcohol related circumstances. This further highlights the advantage of the HARM for providing a more thorough understanding of specific propensities in certain circumstances.

The HARM also revealed that males reported a higher propensity than females to engage in all risky behaviours under both drinking and sober circumstances. This suggests that males may be more willing instigators of intoxicated unprotected or casual sex than females, or at least they are more often intoxicated when engaging in risky sexual behaviour. This is consistent with evidence that frequently intoxicated males
were found to be at increased risk of not using a condom, whereas this was not the case for frequently intoxicated females (Thompson et al., 2005). If males have a greater propensity for unprotected sex then the female recipients are likely to be equally vulnerable to the negative outcomes of this activity, despite their lower propensity to engage in these behaviours as indicated by Study 5.

The complex relationship between alcohol use and gender roles in sexual behaviour have been argued to play a significant part in the victimization of women (Cowley, 2014). This is particularly with respect to the traditional initiators of sexual encounters (males) and interpretation of sexual cues when intoxicated (Cowley, 2014). Interestingly, early reports into attitudes toward alcohol intoxication during sexual assault of acquaintances suggested that females were considered more responsible for the assault when they were intoxicated at similar levels to males (Stormo, Lang, & Stritzke, 1997). However, if males were more intoxicated than females then they were viewed as more responsible (i.e., the female was viewed as a victim). Essentially, the role of varying levels of alcohol intoxication was found to moderate the level of blame assigned to each individual. These findings suggest that the increased propensity for intoxicated, sexual risk taking in males compared to females observed in Study 5 may be linked to the use of alcohol by males for self-facilitation of risky sexual behaviour. Furthermore, the different expectations of alcohol orientated outcomes in males and females may also be relevant in explaining the propensity for sexual risk taking. For example, evidence suggests that college males perceive females as more promiscuous if they are drinkers or drink in bars (Abbey, 2002) whereas findings by Murphy et al. (1998) suggest that ingestion of alcohol by females is associated with reduced estimation of sexual risk, but increased perception of relationship potential. Ultimately, using measures such as the HARM may be helpful in further explaining the role of gender and alcohol use in risky sexual behaviours.
The nature of the findings yielded by the HARM have a distinct advantage over traditional laboratory measures because of its utility for comparing a range of real-world alcohol-related (and unrelated) risky behaviours in a large scale data collection. While existing self-report measures are able to capture real-world behaviours, they do not determine whether these risk behaviours co-occur with alcohol use (e.g., Annis & Graham, 1995; O'Hare, 1997b; Zywiak et al., 1996). Furthermore, the propensity for a range of unexperienced behaviours cannot be estimated when relying on historical report. By contrast, ratings on the HARM offer a present disposition for comparable behaviours that may have never been experienced. This style of risk assessment is consistent with several general risk propensity measures (e.g., Rohrmann, 2002; Weber et al., 2002) and has now, in this thesis, been applied to alcohol-orientated risk propensity.

However, there are some limitations regarding the development of the HARM which should be acknowledged. For example, it would have been beneficial to include more risk measures in the online battery to comprehensively evaluate the HARM. In particular, the inclusion of historical risk-taking measures such as the YAACQ (Read et al., 2004, 2006) and the comprehensive version of the SSS-V (Zuckerman, 1996) (rather than the brief scale) would have provided additional validation tools in demonstrating the utility of the HARM. However, the inclusion of these measures would have been unfeasible within the short administration (30 minutes), which was designed to reduce the effects of fatigue or boredom and increase the likelihood of the scales being completed in a single session.

Finally, the reliability of the HARM subscales in the CFA sample, particularly the injurious scale, was below adequate levels for exploratory purposes (Nunnally & Bernstein, 1994). It is possible that this could be due to sampling variability since the
reliability estimates were larger in the EFA sample. It has already been acknowledged in Chapter 6 that further items may be required to improve the breadth and the reliability of the measure.

Consistent with earlier chapters in this thesis, approach and avoidance inclinations were also measured in Study 5 (using the AAAQ) and their relationships with the HARM were reported. Intense, but not mild, approach inclinations were associated with all the risky behaviours under drinking circumstances only. Because the AAAQ in Study 5 requested generalised ratings over the last week, this suggests that a more enduring intense craving inclination is relevant for engaging in risky behaviour when alcohol is involved. This is consistent with evidence in high risk drinkers that intense approach inclinations are more strongly endorsed than mild approach inclinations, which leads to a greater likelihood of an imbalance relative to the avoidance inclination (McEvoy et al., 2004). In fact, intense approach inclinations have been found to be more strongly associated with ambivalence rather than mild approach or avoidance inclinations (McEvoy et al., 2004). This is consistent with the conceptualisation of craving, according to the Ambivalence Model, as the co-activation of intense approach and avoidance within a two dimensional space (Breiner et al., 1999). This is further supported by recent evidence that intense - but not mild - approach was associated with automatic approach behaviour (Barkby et al., 2012). Moreover, neurosensitization would lead to intense rather than mild craving, which in turn leads to more automatic and impulsive approach behaviour, where a loss of control is more likely (Jentsch & Taylor, 1999). Given that intense craving, as opposed to mild craving, is more likely to lead to an imbalance in craving profile then intense inclinations may be more important for developing a motivational craving state consistent with increased risk taking. The observation of a relationship between the HARM and a more trait-like presence of intense craving for social drinkers in Study 5
supports the validity of the Ambivalence Model for explaining imbalances in inclinational motivation (high approach, low avoidance) which could lead to maladaptive drinking and risk-taking behaviour.

Avoidance was largely unrelated to risky behaviour on the HARM. This was with the exception of one significant, although modest, positive association with the propensity for injury under drinking circumstances, which is difficult to explain. This positive correlation with avoidance conflicts with the negative associations observed between risk taking found in Studies 3 and 4. Instead, it suggests that higher avoidance inclinations are related to increased injurious behaviour when drinking.

**Phase 3 Summary and Future Direction**

In summary, it emerged that the propensity for sexual risk taking, particularly in males, is predominant compared to other risky behaviours when intoxicated, and it is also elevated compared to sober sexual risk taking. By contrast, there was a higher propensity for injurious behaviour compared to other risky behaviours when sober and this remained at similar levels even under drinking circumstances. Furthermore, intense approach-based inclinations over a more enduring period were linked to risky behaviour rather than mild approach or avoidance inclinations. This indicated that the role of intense approach in the relative balance of craving profiles may have strong implications for subsequent behaviour. These unique findings highlight the benefit of the HARM in collecting data that can inform researchers about specific risk-taking behaviours under different circumstances.

Study 5 therefore answers the fourth and final question of this thesis; should suitable self-report alternatives be developed to compliment laboratory tasks for alcohol-orientated risk assessment? Research to date has not offered a means to compare risk behaviour between drinking and sober circumstances, nor has it provided
measures which estimate present and future propensity for alcohol-related risk taking. Therefore the development of a suitable self-report measure was needed, and the first hypothetical alcohol-related risk measure of this kind has undergone a preliminary validation in Chapter 6 of this thesis.

**Conclusion**

Previous studies have shown that exposure to alcohol cues reduces the capacity for inhibition in social drinkers (Muraven & Shmueli, 2006). Accordingly, a key argument for this thesis was that alcohol craving, via the impairment of executive function, would increase simulated risk-taking behaviour on traditional and modified decision-making tasks. While this was not demonstrated experimentally in social drinkers, several important outcomes and implications have been yielded from this investigation:

(a) Approach and avoidance inclinations for alcohol are a valid conceptualisation for characterising motivational craving profiles before and after cue exposure and have enhanced utility when interpreted as a relative balance score between the two. Examining the relative and dynamic balance of these two opposing inclinations was useful in explaining the protective nature of strong avoidance, relative to approach, for regulating approach responses to alcohol cue exposure and taste test consumption behaviour in low risk drinkers. Also, the vulnerability of weakened avoidance, relative to approach, allowed unregulated approach responses and increased the likelihood of maladaptive drinking in high risk drinkers. Ultimately, avoidance was imperative in understanding what distinguishes craving profiles in high and low risk drinkers when exposed to alcohol or non-alcohol cues.

(b) Both approach and avoidance are related to risk-taking behaviour and taste test consumption. This confirmed that dominant avoidance for low risk drinkers and dominant approach for high risk drinkers play a role in resisting and engaging in
maladaptive drinking patterns and subsequent risky behaviours. The implication of these patterns is that “inclinationally prepared” low risk drinkers are afforded additional defences against the losses of control which result as a function of “inclinationally vulnerable” craving profiles exhibited by high risk drinkers.

(c) A modified version of the BART showed external validity for assessing drinking behaviour through its association with taste test beer consumption. This indicates that it may have added utility to that of typical analogue laboratory measures for investigating the link between alcohol use and executive deficits.

(d) A self-reported hypothetical measure was shown to be an appropriate complement to laboratory measures, for evaluating the effect of alcohol on risky behaviour. The unique findings yielded cannot be directly measured using laboratory risk tasks or captured adequately using self-reported historical measures of alcohol use. Specifically, it was revealed that risky sexual behaviour, largely in males when intoxicated, is a primary concern in young Australian adults. This has important implications for the role of gender in influencing engagement in risky sexual activity when intoxicated. In particular, males may become inebriated in order to facilitate risky, unprotected and casual sexual activities. These practices are then consequential for female acquaintances, who were revealed to be characterised by a lower propensity for such activities.

The findings from the studies presented in this thesis have successfully validated a state-based craving assessment method (including a relative balance interpretation), shown that alcohol craving does not impair decision-making in social drinkers, and commenced the development and validation of both a novel alcohol-related risk measure for the laboratory and an alternative measure in the form of a self-report scale. Importantly, these findings represent several key contributions that have been made to
the alcohol craving and decision-making literature, including two new psychometric risk measures that will hopefully be drawn upon in future investigations.
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Appendix

Risk Scenario Questionnaire
Please consider the following hypothetical situations and rate the likelihood that you would engage in the described behaviour. Given the items are hypothetical, please rate them even if they are not currently applicable to you (e.g. an item involving driving if you don’t drive). Your answers should range from NOT LIKELY AT ALL (1) to VERY LIKELY (5).

1. Imagine you are in a committed relationship and you find yourself in a situation where you could have sex with somebody else. However your partner knows them and may find out.

How likely would you be to engage in extra-relationship sex and risk hurting or losing your current partner?

<table>
<thead>
<tr>
<th>When you are sober?</th>
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<td>1</td>
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<tr>
<td>Not likely at all</td>
<td>Very Likely</td>
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<tr>
<td>Very Likely</td>
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</tbody>
</table>

2. Imagine you are in a committed relationship and you find yourself in a situation where you could have sex with somebody else. However your partner does not know them and is unlikely to find out.

How likely would you be to engage in extra-relationship sex and risk hurting or losing your current partner?

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3. Imagine you have the opportunity to have sex with a casual partner but neither of you have a condom.
How likely would you be to have sex with this casual partner and risk a Sexually Transmitted Infection or unwanted pregnancy?

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<tr>
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4. Imagine you have the opportunity to engage in some sexual activity that you know you might later regret.

How likely would you be to engage in sexual activity and risk later feeling shame or regret?

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5. Imagine you have the opportunity to engage in some sexual activity that might cause you some real trouble later on.

How likely would you be to engage in sexual activity and risk serious consequences?

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6. Imagine you meet your partner for lunch and afterwards you feel like taking the remaining work day off and going home.
How likely would you be to leave work early and risk losing your job?

When you are sober?  When you have been drinking?

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7. Imagine you visit the casino with some friends and someone dares you to place a bet on a double-or-nothing game. However the minimum bet would require all of your rent money which is due the next day.

How likely would you be to bet your rent money and risk not being able to pay your rent?

When you are sober?  When you have been drinking?

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8. Imagine you visit the casino with some friends and someone dares you to place bet at a double or nothing game. However the minimum bet require all of the money you need for the taxi ride home.

How likely would you be to bet your taxi money and risk not having a way home?

When you are sober?  When you have been drinking?

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9. Imagine you have no money on you and you need a drink of water. You notice a newsagent stand has a fridge with water in it that you could easily take a bottle from.

How likely would you be to steal the water and risk being caught?

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10. Imagine you are at a bottle shop purchasing some drinks when some underage friends ask you to buy them some alcohol as well.

How likely would you be to purchase alcohol for your friends and risk a heavy fine?

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11. Imagine you are at a bottle shop purchasing some drinks when some underage friends ask you to buy them some alcohol before they drive to a party.

How likely would you be to purchase alcohol for minors and risk them engaging in drink driving?

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</table>
12. Imagine that you about to go out for the day and there is a chance you will be spending several hours out in the sun and it is a hot day. Before you leave you have the opportunity to apply sunscreen.

**How likely would you be to leave without applying sunscreen and risk getting sunburnt?**

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13. Imagine you visiting some friends on a farm and you are given the opportunity to operate a chainsaw on your own for the first time.

**How likely would you be to operate the chainsaw and risk severe injury?**

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14. Imagine you are in a line for a taxi late after a night out. The person behind you becomes aggravated and begins verbally abusing you then starts to push you around a bit.

**How likely would you be to respond aggressively and risk getting injured or legal trouble?**

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15. Imagine you are socializing with some friends on a 3rd story balcony and someone challenges you to jump into the backyard pool, which is adjacent but not directly below.

**How likely would you be to jump into the pool and risk severe injury or death?**

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16. Imagine you are socializing with some friends at night at a beach where you know there are strong riptides. Someone suggests swimming 75 metres out to a pontoon.

**How likely would you be to swim out 75 metres and risk drowning in the strong current?**

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17. Imagine you have gone out to some sand dunes with some friends and someone asks you if you want to drive their quad bike up a steep and rocky embankment where someone was recently killed doing the same activity.

**How likely would you be to drive the bike up the embankment and risk severe injury or death?**

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18. Imagine you have been out drinking with friends and you are quite drunk. The friend that had offered to drive everyone home in your car had left early already.

How likely would you be to drive your friends home and risk a traffic accident?

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19. Imagine you stayed late at work and had a few drinks when you normally drive home. You are feeling quite drunk and you need to get home.

How likely would you be to drive yourself home and risk a traffic accident?

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20. Imagine you promised your friend you would pick them up from the airport after work, however you knocked off early and went drinking with your colleagues. When it is time to leave to pick up your friend, you think you are fine to drive but are over the limit.

How likely would you be to drive to the airport and risk being caught for drink driving?

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21. Imagine you have been out drinking with friends. One of your friends had offered to drive at the start of the night, however when it is time to drive home they appear quite drunk.
How likely would you to accept a lift with your friend and risk being in a traffic accident?

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