Reflection-Impulsivity: A Cognitive Perspective on Binge Drinking

By

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I am the author of the thesis entitled “Reflection-Impulsivity: A Cognitive Perspective on Binge Drinking” submitted for the degree of Doctor of Psychology (Clinical)

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List of Abbreviations

ARQ..........Adolescent Risk Questionnaire
AUDIT.........Alcohol Use Disorders Identification Test
AUQ.........Alcohol Use Questionnaire
BART.........Balloon Analogue Risk Task
BART-A.......Automatic Balloon Analogue Risk Task
BAS..........Behavioural Approach System
BIS..........Behavioural Inhibition System
CFI...........Comparative Fit Index
DSRT.........Domain Specific Risk Taking Scale
DW...........Decreasing-Win Condition
EEG..........Electroencephalogram
ERP..........Event Related Potential
FFMQ.........Five Factor Mindfulness Questionnaire
FW...........Fixed-Win Condition
HSM.........Hello Sunday Morning
I7.............Eysenck Impulsiveness Questionnaire
ImpSS........Impulsive Sensation Seeking Scale
IPIP………….International Personality Item Pool 50-item Big Five Instrument

IST…………..Information Sampling Task

IVE…………..Impulsiveness-Venturesomeness-Empathy Questionnaire

KIMS………..Kentucky Inventory of Mindfulness Skills

MAAS………..Mindful Attention Awareness Scale

MFFT………..Matching Familiar Figures Test

PANAS……..Positive and Negative Affect Scale

RMSEA……..Root Mean Square Error of Approximation

RST………….Reinforcement Sensitivity Theory

RT-18……..Risk Taking Questionnaire

SPSRQ……..Sensitivity to Punishment and Sensitivity to Reward Questionnaire

SPSS………..Statistical Package for Social Sciences

SRMS………..Standardised Root Mean Square Residual

SURPS……..Substance Use Risk Profile Scale

TLFB………..Alcohol Timeline Followback

TLI………..Tucker Lewis Coefficient

UPPS-P……..Impulsive Behaviour Scale

ZKPQ………..Zuckerman-Kuhlman Personality Questionnaire
Abstract

**Background:** Empirical evidence suggests that the binge pattern of drinking, characterised by heavy alcohol intoxication followed by withdrawal is neurotoxic, and is linked to impairments in reflection-impulsivity, i.e., the tendency to gather and evaluate information during decision making. Impaired decision-making patterns characterised by elevated impulsivity and reduced appraisal of information may place young people at greater risk of developing issues of addiction and substance misuse.

A two-factor model of impulsivity has been identified as a significant predictor of alcohol misuse and substance addiction. Reward sensitivity and rash impulsiveness, two domains of impulsive personality, are identified to play an important role in the initiation and maintenance of alcohol misuse; however, the application of this model to the binge pattern of drinking has received little investigation. Further, there has been little integration of impulsive frameworks across personality and cognitive domains, which may prevent a complete understanding of how an impulsive profile may influence alcohol use.

This thesis aimed to integrate personality and cognitive theory of impulsivity by evaluating reward sensitivity, rash impulsiveness, and reflection-impulsivity together, in a community sample. Further, this thesis aimed to build upon this by examining the role of risk taking and trait-mindfulness in binge drinking, as risk and protective factors respectively, to enhance the understanding of the impulsivity-alcohol use relationship.

**Method:** A community sample of 101 adult participants aged 18 to 35 years (M 26.59, SD 3.19) completed a battery of empirically validated self-report and
behavioural measures of rash impulsiveness ($I^2$), reward sensitivity (SPSRQ), reflection-impulsivity (IST), alcohol use (AUQ and AUDIT), risk taking (A-BART and DSRT), and trait-mindfulness (KIMS). Multiple regression techniques were utilised to examine the role of impulsive domains in the prediction of binge drinking, and examine the mediating role of reflection-impulsivity. Further, multiple regression and path analytic techniques investigated the predictive utility of risk taking and mindfulness in binge drinking, and the moderating role of mindfulness was explored for the relationship between impulsivity and binge drinking. For ease of interpretation, evaluation of the thesis aims was conducted over two studies.

**Results:** Results from the first study indicated that reflection-impulsivity was a significant predictor of binge drinking ($p = .01$). Contrary to expectations, neither rash impulsivity nor reward sensitivity significantly predicted binge drinking; however, a significant association emerged between reward sensitivity and binge drinking among high binge drinkers. Differential associations emerged between the two-factor model and reflection-impulsivity, however, reflection-impulsivity did not mediate the relationship between rash impulsiveness and binge drinking.

Results from the second study indicate that risk taking was a significant predictor of binge drinking ($p < .01$), as well as a significant mediator of the relationship between rash impulsiveness and binge drinking ($p = .01$). In contrast to predictions, trait-mindfulness did not predict lower levels of binge drinking, and did not moderate the relationship between reflection-impulsivity and binge drinking. Despite this, trait-mindfulness was associated with lower levels of rash impulsiveness and reward sensitivity, and greater levels of reflection.
Conclusion: Overall, this thesis demonstrated that the decisional patterns indicative of reflection-impulsivity are linked to elevations in binge drinking among young adults. Although the two-factor model was not a significant predictor of binge drinking, it appears that rash impulsiveness may influence patterns of drinking through an enhanced tendency to take risks, whilst the influence of reward sensitivity becomes apparent in higher-levels of binge drinking. With regard to risk and protective factors, the tendency to take risks appears to play an important role in binge drinking behaviour. Although mindfulness was unrelated to binge drinking, the tendency to attend to the present moment was linked to lower impulsivity, and greater reflective patterns during decision making. Overall, this thesis provides support for the utility of integrating impulsive theory across modalities, and provides novel insights into the decisional patterns relevant to the rash impulsive and reward sensitive individual.
Synopsis

Binge drinking is a specific pattern of alcohol consumption that is characterised by episodes of alcohol intoxication, followed by a period of abstinence (Maurage, Petit, & Campanella, 2013). Clinical research indicates that the pattern of successive intoxication and withdrawal is neurotoxic, and is linked to damage to the prefrontal regions of the brain (Maurage et al., 2012; Maurage, Pesenti, Philippot, Joassin, & Campanella, 2009; Obernier, White, Swartzwelder, & Crews, 2002). The binge pattern of drinking is highly prevalent in teens and young adults (Degenhardt et al., 2013), a population that has an enhanced vulnerability to the neurotoxic effects of alcohol (Hermens et al., 2013; Maurage et al., 2013). Consequently, this population is at greater risk of accumulating damage to the prefrontal regions and developing corresponding executive dysfunction, such as impaired decision-making processes, poor memory and attention, reduced inhibitory control, and elevations in impulsivity (Crews & Boettiger, 2009; Hermens et al., 2013). Deficits such as these are known risk factors for addiction and substance use disorders (Crews & Boettiger, 2009; Jentsch & Taylor, 1999), thus, young binge drinkers present as an at-risk cohort for developing problems of addiction.

Impulsivity is a known risk factor that has consistently been linked to problems of alcohol misuse and addiction (Aragues, Jurado, Quinto, & Rubio, 2011). While there is consensus that impulsivity is a multidimensional construct, empirical research has consistently identified two domains of impulsivity as playing a central role in the development and maintenance of problematic forms of alcohol and substance use (Dawe, Gullo, & Loxton, 2004). Reward sensitivity,
the heightened motivation to seek rewards in the environment due to an enhanced propensity toward rewarding stimuli, and rash impulsiveness, the inability to inhibit or modify approach behaviour, are each argued to play a central role in the initiation and continuation of alcohol use, despite the experience of negative consequences (Dawe et al., 2004; Loxton, Nguyen, Casey, & Dawe, 2008a). Empirical research indicates that reward sensitivity and rash impulsiveness consistently predict alcohol and substance misuse (Gullo, Dawe, Kambouropoulos, Staiger, & Jackson, 2010a; Gullo, Jackson, & Dawe, 2010b; Gullo, Loxton, & Dawe, 2014), however, the application of this framework within binge drinkers has received far less attention.

Reflection-impulsivity, the tendency to gather and evaluate information during the decision-making process (Kagan, 1966), is cognitive domain of impulsivity that has emerging relevance in the field of alcohol and substance misuse. Emerging empirical evidence suggests that substance users, problem gamblers, and alcoholics display deficits in decision making processes, characterised by rapid decision making that draws upon minimal information, resulting in greater decisional inaccuracy (Clark, Robbins, Ersche, & Sahakian, 2006; Clark, Roiser, Robbins, & Sahakian, 2009; Lawrence, Luty, Bogdan, Sahakian, & Clark, 2009; Solowij et al., 2012). Recent evaluation of reflection-impulsivity in young binge drinkers indicates that this cohort may display similar decisional impairments to drug users and dependent drinkers (Bø, Billieux, & Landrø, 2016; Townshend, Kambouropoulos, Griffin, Hunt, & Milani, 2014). However, mixed evidence and limited studies prevent conclusions to be drawn as to whether reflection-impulsivity is impaired in young binge drinkers.
A shortcoming of research investigating the role of impulsivity in alcohol misuse is that impulsive domains are generally studied in isolation of one another. It is argued by Gullo et al. (2014) that integration of impulsive domains across multiple modalities may enhance the current understanding of how the impulsivity profile may lead to, and exacerbate the use of alcohol and other substances. Consequently, the primary aim of this thesis was to integrate theory of impulsivity across personality and cognitive domains, by evaluating reward sensitivity, rash impulsiveness, and reflection-impulsivity together, in a sample of young binge drinkers.

In addition, there are a series of proximal cognitive mediators that help explain how an impulsive personality influences alcohol misuse. Specifically, empirical evidence consistently demonstrates that drinking refusal self-efficacy, drinking expectations, and perceived control, significantly mediate the relationship between impulsivity and alcohol or substance misuse (Gullo et al., 2010a; Harnett, Lynch, Gullo, Dawe, & Loxton, 2013; Kabbani & Kambouropoulos, 2013). It is argued in this thesis that additional cognitive and behavioural constructs related to impulsivity may also carry influence over patterns of alcohol misuse. Specifically, risk taking, the tendency to engage in behaviour intended to seek reward with the potential for an undesirable consequence (Bornovalova et al., 2009), is a behavioural domain that is closely associated with impulsivity (Romer, Reyna, & Pardo, 2016). Empirical evidence suggests that the tendency to take risks is linked to elevations in alcohol and substance misuse (de Haan, Egberts, & Heerdink, 2015; Fernie et al., 2013; Miller, Naimi, Brewer, & Jones, 2007).
Further, trait-mindfulness, the tendency to attend to present moment experiences in a non-judgmental and accepting way (Kabat-Zinn, 2003), is implicated in lower levels of impulsivity, as well as adaptive and lower levels of alcohol consumption (Adams et al., 2013; Murphy & MacKillop, 2012; Peters, Erisman, Upton, Baer, & Roemer, 2011). Given risk-taking and trait-mindfulness are each correlates of impulsivity and associated with patterns of alcohol use, a secondary aim of this thesis was to explore the role of risk taking and trait mindfulness, within the impulsivity – alcohol misuse relationship.

To address these aims, this thesis will be presented in nine chapters. Chapter One begins by providing an overview of the nature, and prevalence of binge drinking, and highlights how this pattern differs from other forms of drinking. The neurobiological impact of binge drinking will also be reviewed with reference to negative outcomes such as elevations in impulsivity and increased risk of addiction.

Chapter Two introduces a two-component model of impulsivity that is implicated in the development and maintenance of alcohol and substance misuse. The theoretical and biological processes that underlie alcohol misuse will be reviewed and the applicability of investigating the two-factor model specifically in binge drinking will be discussed.

Chapter Three will introduce a cognitive model of impulsivity that has recently been implicated in binge drinking. This chapter will review patterns of reflection-impulsivity across substance and alcohol users, as well as binge drinkers.
Chapter Four will discuss the importance of evaluating risk and protective factors in the development of addiction, and will review studies that investigate these constructs in the context of impulsivity and alcohol misuse.

Chapter Five will present the thesis rationale, aims, and hypotheses, and will provide an overview of the two studies included in this thesis.

Chapter Six will present the study methodology that was implemented to address the research aims and hypotheses. An overview of participant characteristics, self-report, and behavioural measurement tools used, and the study procedure will be provided.

The first study of this thesis is presented in Chapter Seven. This study is an experimental investigation that will integrate two models of impulsivity, the two-factor model, and reflection-impulsivity, in the prediction of binge drinking.

In Chapter Eight, the second study of this thesis will be presented. This study will explore the role of risk taking and mindfulness as risk, and protective factors, respectively, in binge drinking. Further, this study will investigate the mediating role of risk taking, and the moderating role of mindfulness, within the relationship between impulsivity and binge drinking.

A general discussion of the integrated study findings is provided in Chapter Nine. This chapter will present the major findings across the two studies, and discuss how these findings contribute to the literature. The clinical and research implications of this thesis will be discussed, as will the limitations, and directions for future research.
CHAPTER ONE

Binge Drinking: Conceptualisation and Neurobiological Impact

Overview

The high prevalence of binge drinking in young people has been well documented in a number of studies (e.g., Degenhardt et al., 2013; Livingston, Laslett, & Dietze, 2008; Toumbourou, Hemphill, McMorris, Catalano, & Patton, 2009). While patterns of binge drinking are socially accepted in young people (Courtney & Polich, 2009), there is strong evidence to suggest that intermittent alcohol binging may constitute a greater risk to neurocognitive functioning when compared to regular alcohol consumption (Stephens & Duka, 2008). Specifically, neurobiological evidence suggests that the binge pattern is deleterious for the brain, and young people are particularly vulnerable to sustaining alcohol related damage to the prefrontal regions (Crews & Boettiger, 2009). Despite this, the psychological factors that underlie the development and maintenance of binge drinking behaviour in young people are largely unexplored. As such, the two studies in this thesis will explore how a series of psychological domains may lead to, and be influenced by, binge drinking behaviour in young people.

The purpose of this chapter is to provide an overview of the nature of binge drinking and how this pattern of alcohol use is qualitatively different from other forms of drinking. This will be followed by a review of neurobiological studies that investigate the impact of binge drinking on the executive functions of young people.
Binge Drinking

Conceptualisation and prevalence

Alcohol misuse is a major cause of preventable disease among young people (Mokdad et al., 2016). It is estimated that the societal cost of alcohol-related problems is greater than $14 billion annually (Manning, Smith, & Mazerolle, 2013). Alcohol misuse is the greatest risk factor for disability adjusted life years for young people aged 20-24 years (Mokdad et al., 2016), and accounts for approximately 25% of total deaths globally for those aged 20 – 39 years (World Health Organisation, 2014). The Australian Institute of Health and Welfare (2014) estimate that on average, the onset of alcohol use begins at 15 years of age. Prevalence studies suggest that young people typically drink less frequently compared to older adults; however, they are more likely to drink alcohol at harmful levels on a single drinking occasion (Australian Institute of Health and Welfare, 2014). This pattern of drinking, characterised by the consumption of high volumes of alcohol on a single occasion, is conceptualised as binge drinking.

Currently, there is no single definition of binge drinking utilised in academic research. In Australia, the National Health and Medical Research Council (2009) define a “risky drinking occasion” as the consumption of five or more standard drinks (standard drink equates to that containing 10g of alcohol), while others define binge drinking as the consumption of 5 or more alcoholic drinks for men, and 4 or more drinks for women, within a 2 hour period (Courtney & Polich, 2009). Despite variability within definitions, there is consensus in the understanding that binge drinking is characterised by episodes of
intense alcohol consumption followed by a period of abstinence, making it qualitatively different from other drinking patterns (Maurage et al., 2013).

A commonly used tool to measure binge drinking is the Alcohol Use Questionnaire (AUQ; Mehrabian & Russell, 1978). The AUQ is a self-report questionnaire that provides an indication of binge drinking based on the quantity and frequency of alcohol consumption over the past six months. Use of the AUQ has steadily increased with growing interest in the binge pattern of drinking.

Epidemiological studies indicate that binge drinking is highly prevalent in young people, with higher rates reported in males compared to females (Archie, Zangeneh Kazemi, & Akhtar-Danesh, 2012; Degenhardt et al., 2013). An Australian prevalence study reported that 50% of male and 30% of female adolescents engage in binge drinking weekly. Further, one in five young Australians aged 16-24 engage in high risk or heavy drinking (defined as ≥ 20 standard drinks for males, and ≥ 11 standard drinks for females, in one sitting) at least monthly (Degenhardt et al., 2013; Livingston et al., 2008). Longitudinal studies evaluating binge patterns over time suggest that the binge pattern of drinking begins in adolescence and persists into young adulthood, spanning periods between five to fifteen years (Degenhardt et al., 2013).

The prevalence statistics of binge drinking in young Australians are worrying, particularly given the adolescent brain is more susceptible to sustaining damage from alcohol compared to adults (Hermens et al., 2013; Paus, 2005). Specifically, the adolescent brain undergoes neurodevelopmental changes between the ages thirteen to twenty-five, including continuous maturation of neural circuitry, gains in white matter density, and significant increases in
myelination (Hermens et al., 2013; Paus, 2005). Further, the adolescent brain undergoes significant re-sculpting and synaptic pruning during this period, and these processes are suggested to enhance the brain's vulnerability to sustaining damage from alcohol and substances (Paus, 2005; Schepis, Adinoff, & Rao, 2008). It is argued that these neural processes are linked to greater neurotoxicity during binge drinking, which may lead to a series of changes within the brain that increase the risk of developing disorders of addiction and substance use (Hermens et al., 2013; Schepis et al., 2008).

**Neurobiological damage**

Neurobiological research indicates that the binge pattern of drinking is neurotoxic, particularly to the prefrontal regions of the brain, and can impair a series of neurocognitive functions (Courtney & Polich, 2009; Maurage et al., 2012). Animal studies report that alcohol intoxication has a neurotoxic effect, which can induce inflammatory processes and neuronal degeneration in the corticolimbic systems, neocortex, hippocampus, and cerebellum (Obernier et al., 2002; Pascual, Blanco, Cauli, Miñarro, & Guerri, 2007). Damage to these regions is associated with both short and long term behavioural deficits as well as impairments in learning and memory (Obernier et al., 2002; Pascual et al., 2007).

Further, the process of alcohol withdrawal is also associated with neural changes and cognitive decline. For example, Duka, Townshend, Collier, and Stephens (2003) evaluated the impact of alcohol detoxification on subjects with mild alcoholism ($n = 42$) using a battery of cognitive tasks sensitive to frontal lobe damage. Compared to social drinkers ($n = 43$), the alcohol dependent group displayed impaired performance the cognitive tasks, evidenced by greater errors across tasks, enhanced response latency, and poorer response inhibition.
Importantly, the cognitive deficits observed among the dependent drinkers increased with the number of previous detoxifications. Specifically, those with two or more detoxifications made more errors and were less able to inhibit responses compared to those with one or no detoxification. In addition, cognitive performance was also associated with quantity of alcohol drunk, age of onset of heavy drinking, and years of problem drinking. The study findings indicate that although the process of withdrawal is not a sole factor in predicting cognitive decline, the repeated experience of withdrawal from alcohol does appear to contribute toward the development of cognitive impairment.

Together, the aforementioned studies provide supportive evidence that the processes of alcohol intoxication and withdrawal each play an important role in the development of neural damage and associated cognitive decline (Duka et al., 2003; Obernier et al., 2002; Pascual et al., 2007). However, these studies draw upon rodent samples as well as moderate alcoholics, making generalisations to casual binge drinkers difficult. Maurage and colleagues have built upon this line of research by evaluating neurobiological functioning in samples of young binge drinkers, without issues of addiction. Importantly, evidence reported by Maurage and colleagues indicates that young binge drinkers appear to be at risk of neural and cognitive impairment.

To examine the potential deleterious effects of recurrent alcohol intoxication and withdrawal, Maurage et al. (2009) completed an experimental investigation of the neural effects of short-term binge drinking. Undergraduate students (n = 36) with no history of regular drinking or cerebral impairment underwent nine months of regular binge drinking, consuming a minimum of 10 or more units of alcohol per week. Compared to matched controls, the binge
drinking group displayed marked cerebral dysfunction, evidenced by event related potential (ERP) impairments in information processing and decisional processes. The extent of ERP impairment was proportionate to the severity of binge drinking, providing evidence that neural damage accumulates over time. Despite binge drinkers exhibiting ERP impairments, there was no group differences in psychological or behavioural measures. This suggests that cerebral dysfunction associated with binge drinking may appear early, before behavioural impairments are able to be detected. This study provides evidence that long term binge drinking is not necessary to cause brain damage, rather, short-term binge drinking can produce significant neuronal damage which accumulates over time.

Providing further evidence that damage sustained from binge drinking has a cumulative effect, Maurage et al. (2012) conducted an experimental investigation of varying patterns of alcohol consumption and their impact on cerebral functioning in a student sample (n = 80). Authors compared daily drinkers (3-5 drinks over 5-7 occasions) with moderate-binge (5-12 drinks over 2-3 occasions) and high-binge drinkers (>10 drinks over 3-4 occasions) on measures of cerebral functioning, and recorded subjects’ ERPs. In this study, high-binge drinkers displayed greater cerebral impairments, evidenced by slowed neural processing speed, in comparison to moderate-binge drinkers. This suggests a dose dependent response emerged between binge drinking frequency, severity, and cerebral deficits. In addition, daily drinkers and moderate-binge drinkers consumed the same global amount of alcohol over 1 week; however, the moderate-binge drinkers displayed significant cerebral impairments, whilst no impairments emerged in the daily drinkers. This finding indicates that it is the specific binge pattern of drinking that is deleterious for the brain, more so than
global alcohol intake alone, and that damage sustained accumulates in conjunction with drinking severity and frequency.

The aforementioned studies make an important contribution by highlighting that young, casual binge drinkers without issues of dependence or substance misuse are sustaining neural damage that accumulates with each episode of binge drinking. Further, it appears that damage sustained to the prefrontal regions has implications across behavioural and cognitive domains. The next section will review the impact of alcohol use on executive functions, and discuss the implications of impairments sustained to the prefrontal regions.

**Binge Drinking and Executive Functions**

Alcohol studies have shown that the prefrontal cortex is particularly vulnerable to the neurotoxic effects of alcohol (Abernathy, Chandler, & Woodward, 2010). A major role of the prefrontal cortex is to mediate executive functioning. Executive functions include abilities such as initiation and engagement in goal-directed behaviour, attention, memory, inhibitory control, decision making, planning, information processing, and problem solving (Abernathy et al., 2010; Siddiqui, Chatterjee, Kumar, Siddiqui, & Goyal, 2008). Exposure to alcohol significantly impacts upon the functional and structural integrity of the prefrontal cortex (Abernathy et al., 2010), leading to impairments in executive functioning (Parada et al., 2012; Stephens & Duka, 2008). Studies investigating executive functions in young binge drinkers report that this cohort display impairments in decision making, information processing, response inhibition and inhibitory control (Goudriaan, Grekin, & Sher, 2007; López-Caneda, Holguín, Corral, Doallo, & Cadaveira, 2014; Parada et al., 2012).
For example, Goudriaan et al. (2007) conducted a longitudinal evaluation of the association between drinking patterns, decision making, and impulsivity in a sample of young college students \( (n = 200) \) over a period of two years. Binge drinking was measured via a quantity/frequency index of alcohol use, and participants were categorised into either low-binge, stable moderate-binge, increasing-binge, or stable high-binge drinking groups, based upon their drinking habits over time. Participants in the stable high-binge group displayed poorer performance on behavioural decision making, as measured by the Iowa Gambling Task (IGT; Bechara, Damasio, Damasio, & Anderson, 1994), compared to the low-binge group. In addition, poorer decision-making performance was associated with an early onset of heavy binge drinking, but not with age of onset of drinking in general. Moderate- and high-binge drinkers reported higher levels of impulsivity; however, decision making and impulsivity were not significantly related. These findings indicate that binge-drinkers, particularly those who begin heavy binge drinking at a younger age, display poorer decision making, and higher levels of impulsivity compared to low-binge peers.

To investigate the relationship between binge drinking and cognitive functions related to the prefrontal cortex, Parada et al. (2012) compared undergraduate binge drinkers \( (n = 62; \) those who consumed 6 or more alcohol drinks on a single occasion at least monthly) to a control group \( (n = 60; \) those who never consumed 6 or more alcohol drinks per occasion) on measures of executive functions that are subserved by the prefrontal cortex. In this study, the binge drinkers displayed poorer capacity to retain and manipulate information in verbal working memory compared to the control group. Although causality cannot be determined given the cross-sectional study design, the pattern of performance
exhibited by the binge group is indicative of impaired executive functions, as an extension of damage sustained to the prefrontal cortex.

Further evidence of impaired executive functions in binge drinkers was reported by López-Caneda et al. (2014), who investigated the impact of drinking habits over time. Authors examined the neural activity of undergraduate students \( n = 57 \) completing the Go/No-Go task (Miller, Schäffer, & Hackley, 1991), a response execution and inhibition task, using EPR and electroencephalogram (EEG) techniques. Binge drinkers, identified as those who consumed six or more standard alcoholic drinks per occasion at least once per week, displayed neural anomalies associated with poor response inhibition, compared to the control group. Further, neural dysfunction in the frontal regions was associated with earlier onset of regular drinking, greater speed of alcohol consumption, and greater weekly alcohol intake. This pattern of results indicates that episodic alcohol intoxication, together with an earlier age of onset of regular drinking, increases the susceptibility to experience neural anomalies linked with response inhibition (López-Caneda et al., 2014).

Taken together, these studies provide supportive evidence that the binge pattern of drinking may impair neural activity in the frontal regions, and is associated with poorer decision-making patterns, working memory, and elevated impulsivity. Damage to the prefrontal cortex and associated impairment in these abilities is implicated in the development of addiction and substance use disorders (Crews & Boettiger, 2009).

Specifically, the accumulation of neural damage following alcohol consumption is associated with difficulty inhibiting and controlling behaviour,
and a greater tendency to act impulsively. These alterations in behaviour promote elevated alcohol use through the diminished capacity to inhibit and regulate behaviour, which in turn exacerbates the process of neurodegeneration. This process continues in a feedback loop, and is argued to explain the development of addiction and substance use disorders (Crews & Boettiger, 2009; Schepis et al., 2008).

Empirical research suggests that the behavioural manifestation of prefrontal damage and associated executive impairment largely comprises behaviour that is impulsive (Aragues et al., 2011; Bechara, 2005). Impulsivity is considered highly relevant in driving initial alcohol use, as well as enhancing the risk of developing problems of addiction and substance abuse (Bechara, 2005; Courtney et al., 2012). Clinical studies investigating the role of impulsivity in alcohol use have predominantly employed clinical samples or student samples who engage in hazardous patterns of drinking. Consequently, there has been far less investigation of the role of impulsivity specific to the binge pattern of drinking. As such, the focus of this thesis will explore how multiple domains of impulsivity may lead to, and be influenced by, binge drinking behaviour in young people.

Summary

While many young people engage in social binge drinking, the repeated pattern of acute alcohol intoxication followed by withdrawal places this cohort at risk of developing neural damage, and associated executive impairments. Although many young people do not go on to develop negative outcomes associated with casual drinking, impaired executive functions including poorer
decision making, response inhibition, and elevations in impulsivity, can enhance the risk of social drinking developing into hazardous alcohol use, or dependence.

The next chapter will examine the role of personality driven impulsivity in hazardous alcohol use by reviewing a well-established model of impulsivity, the two-factor model. The findings of these studies will be discussed with reference to the neurobiological mechanisms that underpin these processes, and it will be argued that the two-factor model may be relevant in understanding binge drinking.
CHAPTER TWO

Understanding Impulsivity and Alcohol Use

Overview

The previous chapter discussed how the binge pattern of drinking is deleterious for the brain, placing young people at risk of sustaining neural damage to the prefrontal regions. In addition to these processes, a strong body of empirical evidence suggests that personality characterised by elevated impulsivity is implicated in the onset and maintenance of alcohol misuse. The present chapter will introduce the construct of impulsivity, and discuss a well-established two-factor model of impulsivity that is involved in the development of alcohol misuse and addiction. The two factors, rash impulsiveness and reward sensitivity (Dawe & Loxton, 2004), will be reviewed with reference to the theoretical and biological processes that underlie alcohol misuse. In this chapter, it will be argued that the application of the two-factor model to binge drinking may provide important insights into how an impulsive personality may drive binge drinking behaviour.

Impulsivity

Impulsivity is a multidimensional construct defined as the tendency to participate in rash or maladaptive behaviour, without reflection, forethought, or planning (Dawe et al., 2004; Evenden, 1999b). Impulsivity is largely conceptualised as a dimension of personality that varies among individuals, and has been extensively studied within numerous frameworks of personality (Cloninger, 1987; Eysenck, 1967; Gray, 1987). Behavioural expressions of impulsivity include rapid responding without reflection or planning, limited
attention, and engagement in behaviour that is risky or inappropriate to the situation, that often results in undesirable outcomes (Evenden, 1999b).

Impulsivity plays an important role in normal human behaviour as well as psychopathology (Evenden, 1999b; Gullo et al., 2014). Although largely overlooked in the literature, functional impulsivity, such as quickly taking advantage of unexpected opportunities without forethought, can be adaptive across a variety of situations (Dickman, 1990). More prominent in the literature, however, are studies of maladaptive impulsivity. Elevated or heightened impulsivity is generally considered maladaptive, as it is associated with greater levels of risk taking behaviour, poor decision-making processes, and alcohol abuse (Aragues et al., 2011; de Wit, 2009). Elevated impulsivity is also implicated in a variety of mental illnesses including mania, personality disorders, attention deficit hyperactivity disorder, and substance use disorders (Evenden, 1999a; Gullo et al., 2014).

**Impulsivity and Alcohol Misuse**

Strong clinical evidence consistently reports associations between heightened impulsivity and alcohol misuse (Dawe et al., 2007; Gullo et al., 2010a; Gullo et al., 2010b; Gullo et al., 2014). It is argued that an impulsive personality may predispose an individual to alcohol problems through patterns of cognition, affect, and behaviour (Stautz & Cooper, 2013). Known mechanisms linking impulsivity to alcohol misuse include a heightened vulnerability to the effects of alcohol, an increased tendency to use alcohol to regulate emotions, and a propensity to engage in risky behaviour (Stautz & Cooper, 2013).
Despite significant links between trait impulsivity and alcohol misuse, a causal link between these constructs is difficult to establish. While prospective studies indicate that adolescents with elevated impulsivity may be more prone to excessive alcohol use (George, Connor, Gullo, & Young, 2010; Stautz & Cooper, 2013), longitudinal studies suggest that prolonged alcohol misuse can enhance impulsivity via damage sustained to the prefrontal regions (Aragues et al., 2011). Thus, rather than a unidirectional association between elevated impulsivity and alcohol misuse, there is a general consensus that the link between impulsivity and alcohol use is reciprocal (Crews & Boettiger, 2009; Stautz & Cooper, 2013). Specifically, it appears that elevated levels of trait impulsivity increase the likelihood of consuming hazardous levels of alcohol, and the neurobiological damage yielded by alcohol misuse subsequently exacerbates impulsivity (Crews & Boettiger, 2009; Schepis et al., 2008; Stautz & Cooper, 2013).

Given impulsivity is a multidimensional construct, research continues to explore multiple facets of impulsivity together with alcohol use in order to understand which facets enhance the risk of misuse and addiction (Gullo et al., 2014). Exploration of impulsivity through factor analytic methods have identified two distinct factors, rash impulsiveness, and reward sensitivity, as particularly relevant in understanding the processes that underpin alcohol misuse (Franken & Muris, 2006b; Quilty & Oakman, 2004). Empirical research suggests that these two factors of impulsivity each consistently predict alcohol misuse through unique pathways, and together, may enhance the risk of alcohol use developing into abuse or dependence (Dawe & Loxton, 2004). This has led to the development of the two-factor model, which models both rash impulsiveness and reward sensitivity together in the prediction of alcohol misuse. The two-factor
model has strong biological underpinnings and provides a framework for understanding how dimensions of impulsivity may drive alcohol misuse and addiction (Gullo & Dawe, 2008).

**Reward Sensitivity**

Reward sensitivity, described as the degree to which an individual experiences the rewarding aspect of a stimuli as pleasurable, is suggested to drive the initiation of alcohol use (Dawe et al., 2004). Individuals high in this domain experience rewarding stimuli, such as food, alcohol, or substances, as more pleasurable, and as such, experience greater motivation to seek out these stimuli in the environment (Gullo, Ward, Dawe, Powell, & Jackson, 2011).

The theory of reward sensitivity evolved from research by Gray (1987) who developed Reinforcement Sensitivity Theory (RST; Gray, 1987). According to this theory, personality traits are biologically driven, based on the brains sensitivity, or reactivity, to reinforcing stimuli (Pickering & Gray, 2001). Variation in reward sensitivity is suggested to be driven by the Behavioural Approach System (BAS). The BAS responds to specific stimuli associated with reward, and drives motivational and approach behaviour (Pickering & Gray, 2001). It is suggested that individuals high in reward sensitivity have a highly responsive BAS, and are more likely to experience stronger reinforcement and motivation to seek out substances compared to those with lower levels of reward sensitivity (Pickering & Gray, 2001).

It is theorised that variation in reward sensitivity is related to functioning of the mesolimbic dopamine system (Beaver et al., 2006). Dopaminergic pathways within this system respond to stimuli that prompt goal directed
behaviour (Dawe et al., 2004). While heightened reward sensitivity may not necessarily lead to frequent impulsive behaviour, those high in this trait are more susceptible to the reinforcing aspects of stimuli such as alcohol (Gullo & Dawe, 2008), and as such may act impulsively in response to reward related cues (Stautz & Cooper, 2013).

Frequently used tools to measure reward sensitivity in alcohol use include the BAS scale (Carver & White, 1994), and the Sensitive to Punishment Sensitive to Reward Questionnaire (SPSRQ; Torrubia, Ávila, Moltó, & Caseras, 2001). The BAS is a self-report measure used to assess individual differences that reflect sensitivity to appetitive motivation, whilst the SPSRQ examines BAS functioning to specific rewards such as money, sex, social power and approval. Scores on these measures provide an indication of responsiveness to appetitive cues and the capacity to employ approach behaviour in situations of potential reward (Stautz & Cooper, 2013).

**Rash Impulsiveness**

The second impulsive domain within the two-factor model is rash impulsiveness. Rash impulsiveness is defined as behaviour that is spontaneous and unplanned, without consideration of potential consequences (Dawe et al., 2004). The theory of rash impulsiveness evolved from Eysenck and Eysenck (1985) personality theory. Eysenck and Eysenck (1985) identified extraversion, neuroticism, and psychoticism as biologically based dimensions of personality. Impulsivity was identified as a sub-factor of these dimensions, where rash impulsiveness is made up of components that correspond with psychoticism, and extraversion (Eysenck, Pearson, Easting, & Allsopp, 1985).
Rash impulsiveness is associated with poor inhibitory control, manifesting as difficulty, or an inability, to stop approach behaviour even when faced with negative consequences (Loxton et al., 2008a). The neurobiological processes underlying rash impulsiveness relate to functioning of the orbitofrontal cortex and anterior cingulate cortex, as well as their associated connections with various cortical and limbic areas (Dawe et al., 2004; Horn, Dolan, Elliott, Deakin, & Woodruff, 2003). It is argued that functioning of these processes correspond with individual differences in the ability to inhibit a response (Dawe et al., 2004).

A commonly used measure in the literature of rash impulsiveness and alcohol use is the Impulsiveness subscale of the Eysenck Impulsiveness Questionnaire (I7; Eysenck et al., 1985). The I7 is derived from Eysenck’s model of personality, and provides an indication of the propensity to act rashly or spontaneously across a variety of settings.

The Two-Factor Model and Alcohol Use

Although both rash impulsiveness and reward sensitivity each uniquely predict alcohol misuse, a series of empirical studies suggest that when evaluated together, these domains offer the most explanatory power in the prediction of alcohol misuse (Gullo et al., 2010b; Gullo et al., 2014; Gullo et al., 2011). The initial development of the two-factor model drew on research investigating personality and neurobiology in the context of drug use that was later replicated in alcohol-using cohorts. In this model, it is hypothesised that elevations in reward sensitivity lead to an initial propensity to engage in substance use; the rewarding aspects of the substance are experienced as more pleasurable, thus driving motivation for continued use (Dawe et al., 2004). The continued use of substances
leads to the BAS reward pathways becoming sensitised, which acts to further enhance the reinforcing effects of drug use (Beaver et al., 2006).

The role of rash impulsiveness is hypothesised to drive persistent drug use despite negative consequences, due to the diminished ability to inhibit behaviour once an approach response has commenced (Dawe et al., 2004). It is argued that the ability to inhibit impulsive behaviour progressively diminishes in conjunction with the accumulation of neural damage sustained from substance misuse. During this process, damage accumulates in the orbitofrontal cortex and anterior cingulate due to chronic activation of dopaminergic pathways (Jentsch & Taylor, 1999). This process may degrade the ability to inhibit drug use behaviour, despite negative consequences such as withdrawal symptoms or injury. Together, it is argued that the two-factor model plays a role in occasional substance use developing into abuse and dependence through an increased propensity to try substances, together with a reduced capacity to inhibit approach behaviour (Dawe et al., 2004).

Although the two-factor model has been extensively studied across a variety of contexts, including alcohol and substance misuse, addiction, and in treatment seekers (Gullo et al., 2010b; Gullo et al., 2011; Harnett et al., 2013), the model has seldom been applied specifically to the binge pattern of drinking. As such, the following section will provide a comprehensive review of studies that have investigated the two-factor model in samples of young alcohol users, and will discuss how this model may be applied to the prediction of binge drinking.

Examining the contribution of both rash impulsiveness and reward sensitivity in the prediction of alcohol misuse, Gullo et al. (2010b) investigated
the two-factor model in a young student sample \((n = 165)\). Hazardous alcohol use was assessed with the Alcohol Use Disorders Identification Test (AUDIT; Saunders, Aasland, Babor, de la Fuente, & Grant, 1993), while rash impulsiveness and reward sensitivity were measured with the I7 and the sensitivity to reward subscale of the SPSRQ, respectively. In addition, authors hypothesised that additional mechanism may underpin the relationship between impulsivity and alcohol use, and thus evaluated reversal learning as a mediating factor. In this study, the two-factor model significantly predicted alcohol misuse. Specifically, rash impulsiveness explained 5% of the variance in alcohol misuse, whilst reward sensitivity explained 4% of the variance. Reversal learning did not mediate this relationship, suggesting that elevations in impulsive personality predicted alcohol misuse, however, this relationship was not explained by reversal learning.

Extending these findings, Gullo et al. (2011) applied the two-factor model to both alcohol and illicit drug use in samples drawn from Australia and the United Kingdom \((n = 499)\). Using structural equation modelling techniques, one- and two-factor models were compared to determine the unique, and combined role of rash impulsiveness and reward sensitivity in the prediction of alcohol and illicit drug use. When applied to alcohol misuse, the two-factor model was of superior fit to the data compared to one-factor models, and accounted for 26%, and 14% of the variance in hazardous alcohol use in British and Australian samples, respectively. A similar pattern emerged when applied to illicit drug use. The two-factor model was of superior fit to the data compared to one-factor models, and accounted for 27%, and 6% of the variance in drug use in the British and Australian samples, respectively. Importantly, rash impulsiveness was a more robust predictor of maladaptive alcohol and drug use in both models. Reward
sensitivity was less consistently associated with alcohol and substance misuse; however, the superior fit of the two-factor model indicates that rash impulsiveness and reward sensitivity are distinct facets of impulsivity that each play a differential role in substance misuse.

Similarly, Gullo et al. (2010a) investigated the differential role of rash impulsiveness and reward sensitivity in the prediction of alcohol misuse, and evaluated the role of cognitive mechanisms within the impulsivity – alcohol use relationship. Authors evaluated the mediating role of alcohol expectancies and drinking refusal self-efficacy together with the two-factor model, in a sample of students \((n = 342)\), and treatment-seeking substance abusers \((n = 121)\). The hypothesised model was of good fit to the data and accounted for 68% of the variance in the young adult sample, and 17% variance in the treatment seeking sample. Drinking refusal self-efficacy partially mediated the relationship between rash impulsiveness and alcohol misuse in the student sample, and fully mediated the relationship in treatment seekers. Links between reward sensitivity and alcohol misuse were more complex. Specifically, reward sensitivity predicted greater positive drinking expectancy, which led to lower drinking refusal self-efficacy, which in turn predicted alcohol misuse. The study findings suggest that those high in rash impulsiveness may experience more difficulty refusing alcohol, while those high in reward sensitivity have greater positive expectations of drinking. Based upon the study findings, Gullo et al. (2010a) argued that alcohol misuse is influenced by both personality and cognitive variables, and that exploration of each may enhance the understanding how an impulsive personality may lead to alcohol misuse.
Building upon this research, Harnett et al. (2013) replicated the abovementioned mediation model in a sample of undergraduate university students \((n = 378)\) and found that the mediation model accounted for 55% of the variance in hazardous drinking. Consistent with Gullo et al. (2010a), reward sensitivity predicted greater positive alcohol expectancies, which in turn predicted lower drinking refusal self-efficacy. Further, positive alcohol expectancies and drinking refusal self-efficacy significantly mediated the relationship between reward sensitivity and hazardous drinking, whilst drinking refusal self-efficacy partially mediated the relationship between rash impulsiveness and hazardous drinking. Inconsistent with hypotheses, rash impulsiveness also predicted greater positive alcohol expectancies. Together, findings reported in Gullo et al. (2010a) and Harnett et al. (2013) highlight the importance of investigating cognitive mediators within the two-factor model in order to enhance understanding of how an impulsive personality acts to influence alcohol misuse.

To expand this research further, Kabbani and Kambouropoulos (2013) hypothesised that perceived impaired control, defined as the belief in one’s capacity to control alcohol consumption (Heather, Tebbutt, Mattick, & Zamir, 1993), would mediate the relationship between rash impulsiveness and alcohol misuse. Consistent with Gullo et al. (2010a) and Harnett et al. (2013), positive drinking expectancies mediated the relationship between reward sensitivity and alcohol use, and in support of the hypothesis, rash impulsiveness positively predicted impaired control, which in turn predicted alcohol use. Together, the hypothesised mediation model explained 64% of the variance in alcohol use.

Overall, the findings from Gullo et al. (2011), Gullo et al. (2010a), Harnett et al. (2013) and Kabbani and Kambouropoulos (2013) provide support for the
hypothesis that rash impulsiveness and reward sensitivity play a differential role in predicting alcohol misuse. Specifically, it appears reward sensitivity may enhance alcohol misuse through greater expectations that drinking will be a positive experience, which in turn reduce self-efficacy in the ability to refuse alcoholic drinks. Further, rash impulsiveness appears to be a more robust predictor of alcohol misuse, which can be explained through the reduced ability to refuse drinking, together with the reduced belief in the ability to control, or regulate alcohol consumption. Importantly, these studies highlight the utility of exploring personality, and cognitive variables together, to establish risk factors that may place young, casual drinkers at greater risk of developing problematic patterns of alcohol use.

The Two-Factor Model and Binge Drinking

In the context of binge drinking, the application of the two-factor model has received far less investigation. At present, two studies have examined associations between sensation seeking and disinhibition, constructs conceptually similar to reward sensitivity and rash impulsivity, and binge drinking (Castellanos-Ryan, Rubia, & Conrod, 2011; Franken & Muris, 2006a).

First, Franken and Muris (2006a) investigated personality differences in drug and alcohol use by evaluating the Behavioural Inhibition System (BIS) and the Behavioural Approach System (BAS), in a sample of non-clinical college students \( (n = 276) \). The BIS/BAS scales (Carver & White, 1994) provided a measure of punishment and reward sensitivity; drinking habits and binge drinking were identified using a quantity-frequency index of number of drinks and drinking days during the last 6 months. In this study, BAS Fun Seeking, a BAS subscale indicative of sensation seeking, was significantly correlated with
quantity of alcohol use, frequency of binge drinking, and number of illegal substances used. This indicates that participants who displayed elevations in the tendency to seek thrilling or exciting experiences, reported more frequent binge episodes and drug use.

Similarly, Castellanos-Ryan et al. (2011) investigated the shared and unique impact of self-report and cognitive measures of sensation seeking and disinhibition on binge drinking behaviour among a sample of adolescents ($n = 76$). In this study, sensation seeking was measured using the sensation seeking subscale of the Substance Use Risk Profile Scale (SURPS; Woicik, Stewart, Pihl, & Conrod, 2009), and the Go/No-Go task (Miller et al., 1991), while disinhibition was measured with the impulsivity subscale of the SURPS and the Stop Task (Rubia, Smith, & Taylor, 2007). Binge drinking was identified as the consumption of five or more standard drinks per drinking occasion for males, and four or more drinks for females, in the past six months. Regression analyses indicated that sensation seeking was uniquely associated with binge drinking frequency, accounting for 30% the variance, while response inhibition did not uniquely explain variance binge drinking frequency. This pattern of results indicates that elevations in reward-related personality and corresponding executive functions were associated with greater frequency of binge drinking, while self-report and behavioural measures of disinhibition appeared unrelated to the binge pattern of drinking.

Taken together, the findings of Franken and Muris (2006a) and Castellanos-Ryan et al. (2011) provide preliminary support for the argument that elevated reward sensitivity may be relevant to understanding binge drinking behaviour. However, further research is needed to replicate and expand upon
these findings. Although Franken and Muris (2006a) utilise the Dutch version of the BAS scale as a measure of reward sensitivity, authors report the scales obtained low to moderate reliability, evidenced by Cronbach’s alphas ranging from .45 to .78. As such, replication using reliable and valid measures of reward sensitivity are needed to build upon the study findings.

Further, the sample utilised in Castellanos-Ryan et al. (2011) included a large proportion of adolescents who exhibited either high substance use risk factors, or none of the substance use risk factors, in order to enhance variability within the sample. This sampling method may limit the generalisability of the study findings and inflate links between impulsivity and binge drinking. Thus, replication within a community sample is required to verify whether these patterns consistently emerge within a community sample.

**Summary**

The similar pattern of results reported across samples of substance users, treatment seeking adults, and students, suggests that the two-factor model is relevant in explaining a variety of drinking patterns, including social drinking, as well as more hazardous forms of alcohol and substance use. As such, it is argued in this thesis that the two-factor model may be applicable to the prediction of binge drinking, within a community sample.

It is argued that understanding the contributing factors of binge drinking behaviour is important, given the binge pattern of drinking is qualitatively different from other forms of drinking and places young people at elevated risk of alcohol misuse and dependence (Crews & Boettiger, 2009; Hermens et al., 2013). Further, specific evaluation of the binge pattern may provide additional
information to that gathered by the AUDIT, which is at present, is the predominant measure of alcohol use in studies of the two-factor model (e.g., Gullo et al., 2010a; Gullo et al., 2011; Harnett et al., 2013; Kabbani & Kambouropoulos, 2013).

The neurobiological underpinnings of reward sensitivity and rash impulsiveness provide further support for the argument that the two-factor model may be relevant in understanding binge drinking behaviour. Specifically, preliminary work by Lyvers, Duff, Basch, and Edwards (2012) report that rash impulsiveness is associated with dysfunction in the dorsolateral prefrontal and orbitofrontal systems, whilst reward sensitivity is linked to orbitofrontal dysfunction. Although these regions are linked to the expression of impulsive behaviour, they are also vulnerable to neurotoxicity following repeated binge episodes (Crews & Boettiger, 2009).

Finally, given a series of cognitive mediators’ help explain how an impulsive personality may lead to hazardous levels of drinking, the investigation of additional cognitive mechanisms may add to this line of research. A review by Gullo et al. (2014) advocates for the integration of impulsive theory across multiple modalities, such as self-report, behavioural, and cognitive techniques, in order to understand how multiple expressions of impulsivity act to influence drinking behaviour. Thus, the present thesis aims to investigate how a relatively new cognitive model of impulsivity, reflection-impulsivity, may interact with, and influence patterns of binge drinking, together with the two-factor model.

The following chapter will provide an overview of reflection-impulsivity and discuss how this construct relates to binge drinking and substance misuse by
means of attentional and decision-making patterns. A series of studies that have investigated reflection-impulsivity in samples of binge drinkers and substance users will be reviewed, and discussed with reference to how this model may relate to the two-factor model.
CHAPTER THREE

Exploring the role of Reflection-Impulsivity in Binge Drinking

Overview

The previous chapter discussed how rash impulsiveness and reward sensitivity each play a role in alcohol misuse, and may be relevant in driving the binge pattern of drinking. Although this model is well established, the importance of integrating theory across impulsive modalities is needed to gain additional insights into how personality and cognitive factors may, together, drive drinking behaviour.

Recent empirical evidence suggests that reflection-impulsivity (Kagan, 1966), a cognitive model of decision making, is impaired in substance using and alcohol addicted populations (Clark et al., 2006; Clark et al., 2009; Lawrence et al., 2009). Preliminary evidence suggests that young binge drinkers may also display impairments in decisional processes (Townshend et al., 2014), however, studies exploring reflection-impulsivity in binge drinkers provides inconsistent evidence (Banca et al., 2015; Bø et al., 2016). The present chapter will introduce reflection-impulsivity and review a series of studies that investigate patterns of reflection in alcohol and substance users, and young binge drinkers. In this chapter, it will be argued that reflection-impulsivity is an important domain of impulsivity that may be relevant in understanding patterns of binge drinking in young people.

Reflection-Impulsivity

An emerging construct investigated for its role in driving alcohol and substance misuse is “Reflection-Impulsivity”. Reflection-impulsivity is a
cognitive subtype of impulsivity that refers to individual differences in the
tendency to gather and evaluate information prior to making a decision (Kagan,
examining cognitive patterns of problem solving in children. According to this
theory, problem solving during childhood was proposed to fall on a bimodal
continuum, spanning from reflective to impulsive (Kagan, 1966). Reflective
patterns of processing were proposed to incorporate comprehensive gathering of
information, evaluation of options, and hypothesis testing, resulting in greater
accuracy in performance (Kagan, 1966). In contrast, children with impulsive
patterns of processing displayed a tendency to appraise less information, less
consideration of the accuracy of cognitions, and thus exhibit more inaccuracies in
performance. As such, a core feature of reflection-impulsivity is the association
between the amount of information appraised, and the accuracy of a subsequent
decision (Evenden, 1999a).

Research investigating reflection-impulsivity in adults has received far
less attention until recently. Studies of reflection-impulsivity in adulthood are
emerging in the context of alcohol and substance use. Measures of reflection-
impulsivity primarily utilise behavioural problem-solving tasks that assess the
quality of problem solving performance. A series of empirical studies indicate
that adults exhibit similar patterns of reflective or impulsive problem-solving
styles to that of children (Lawrence et al., 2009; Quiroga, Martínez-Molina,
Lozano, & Santacreu, 2011). Specifically, reflective adults are proposed to
demonstrate a tendency to consider all relevant information before making a
decision, and as a consequence, performance on behavioural tasks typically
includes higher response latency and greater accuracy (Quiroga et al., 2011).
Adults who are more impulsive on the other hand demonstrate a tendency to make decisions before obtaining all relevant information, and thus exhibit lower response latency and perform with greater inaccuracy (Quiroga et al., 2011). Behavioural tasks used to measure reflection-impulsivity have evolved throughout the literature, and will be discussed in the following section.

**Measures of Reflection-Impulsivity**

The original behavioural task used to measure reflection-impulsivity is the Matching Familiar Figures Test (MFFT; Kagan et al., 1964). The MFFT is a visual comparison task, where a subject is presented with a drawing, such as a tree, and six similar variations of the drawing. The subject is required to select the identical image that matches the exemplar (Kagan et al., 1964). Despite its wide use, there are issues regarding ability of the MFFT to elicit a pure measure of reflection-impulsivity, as the task places high demands on visual search, visual working memory, and strategy use (Clark et al., 2006). This is problematic particularly in studies of reflection-impulsivity in substance use, as substance using groups’ exhibit cognitive deficits in visual and executive functioning, which may increase MFFT error rates (Fox et al., 2002; Ornstein et al., 2000). To circumvent these limitations, the Information Sampling Task (IST) was designed to provide a purer measure reflection-impulsivity and decision making, by measuring the level of information sampling without placing demands on visual processing and working memory (Clark et al., 2006).

The IST is a computer-generated task that presents a number of trials to be completed. A subject is presented with a 5 x 5 matrix of grey squares; an underlying colour is revealed beneath each square when opened. The subject is asked to open as many boxes as needed to identify which of two underlying
colours is in the majority. The subject may open as many boxes as they like before making a decision. Correct decisions are awarded a number of points.

There are two conditions within the IST, the Fixed Win (FW) condition and the Decreasing Win condition (DW). In the FW condition, a correct decision is awarded 100 points, regardless of the number of boxes opened. In contrast, in the DW condition, the number of points awarded decreases with every box opened. This condition offers a conflict between obtaining points, and having a high probability of making a correct decision. The IST extracts a direct measure of information sampling, described as the probability of selecting the correct answer at the time of making a decision. This is based upon the amount of information sampled (number of boxes opened) prior to making that decision (Clark et al., 2006).

Consistent with performance on the MFFT, highly impulsive individuals are likely to exhibit IST performance characterised by the sampling of less information, making decisions at greater levels of uncertainty, faster response time, and a greater number of errors on the task (Clark et al., 2006; Clark et al., 2009). In contrast, the IST performance of reflective individuals is characterised by the sampling of more information, decisions are made at a higher probability of selecting the correct response, greater response time, and fewer errors (Clark et al., 2006; Lawrence et al., 2009). A recent factor-analytic study investigating multiple self-report and behavioural measures of impulsivity found that IST variables and the MFFT loaded onto a single factor, indicating the IST is a valid measure of reflection-impulsivity (Caswell, Bond, Duka, & Morgan, 2015). Further, alternative measures of impulsivity loaded onto different impulsive
factors, which suggests that reflection-impulsivity is a distinct subtype of impulsivity (Caswell et al., 2015).

**Reflection-Impulsivity in Alcohol and Substance Use**

Since inception, the IST has primarily been used to investigate reflection-impulsivity in adult samples engaging in alcohol and substance use. While a growing body of evidence suggests that reflection-impulsivity is a relevant domain of impulsivity in alcohol and substance misuse, this model has typically been studied in isolation of other impulsive frameworks. The following section will review studies that have investigated reflection-impulsivity in binge drinkers, alcohol, and substance using cohorts. Due to methodological issues surrounding the MFFT, the following studies reviewed include only those that administered the IST as a measure of reflection-impulsivity. Further, the utility of integrating this model together with rash impulsiveness and reward sensitivity will be discussed.

In development of the IST, Clark et al. (2006) compared patterns of reflection among amphetamine \((n = 24)\), and opiate \((n = 40)\) users, former substance users abstinent for a minimum of one year \((n = 24)\), and a non-drug using control group \((n = 26)\). In this study, analysis of variance revealed a significant effect of substance use on IST performance. Specifically, substance users displayed significantly reduced information sampling on the IST, evidenced by opening fewer boxes, tolerating a lower probability of being correct at the point of decision, and obtaining more errors, compared to the control group. Interestingly, the ex-substance users displayed a similar pattern of information sampling, suggesting that patterns of reflection-impulsivity remain stable following a prolonged period of abstinence. Performance on the IST was
unrelated to duration of drug use, suggesting that the effect could be related to premorbid vulnerability. In addition, performance on the IST significantly differed between the FW and DW conditions, indicating that each group adjusted their performance based on the altered characteristics of each condition. There was no difference in IST performance between groups in the DW condition, suggesting that each group was motivated to win points. It was argued by Clark et al. (2006) that the decisional patterns observed among the drug and ex-users were similar to that of samples with sustained damage to the frontal lobe and orbitofrontal cortex, such as those reported in Bechara, Dolan, & Hindes. (2002) and Berlin, Rolls, & Kischka. (2004). Thus, Clark et al. (2006) suggested that these regions may be implicated in patterns of reflection-impulsivity.

Building upon these findings, Clark et al. (2009) administered the IST to a sample of current and former ecstasy users \( (n = 46, \text{ and } n = 14, \text{ respectively}) \), regular cannabis users \( (n = 15) \), and drug-naïve controls \( (n = 19) \). Cannabis users displayed poorer reflection evidenced by opening fewer boxes, and tolerating more uncertainty when making a decision, compared to the ecstasy and drug-naïve controls. Interestingly, males in the cannabis group displayed significantly reduced information sampling compared to females, suggesting decisional patterns may vary between genders. Inconsistent with authors hypotheses, there was no significant difference in IST performance between the ecstasy and drug-naïve groups. Corresponding with Clark et al. (2006), each group adjusted their performance between the FW and DW conditions, demonstrating the overall sample was sensitive to the change in reward condition. Results extend those of Clark et al. (2006) by identifying that cannabis users also exhibit impulsive patterns of decision making.
Building on these findings, Solowij et al. (2012) explored the impact of parameters of cannabis use, such as quantity, frequency, duration, and onset of use, on the decisional patterns of adolescents ($n = 175$). Performance on the IST was compared between cannabis users ($n = 48$), alcohol users ($n = 65$), and a control group ($n = 62$). Consistent with Clark et al. (2009), the cannabis users exhibited impaired reflection-impulsivity as participants opened fewer boxes, tolerated a significantly lower probability of selecting the correct response, responded faster, and made more errors in the FW condition, when compared to the alcohol and control groups. Further, IST performance among the cannabis users was correlated with age of onset, duration, and frequency of cannabis use. Interestingly, there was no difference in performance on the IST between the alcohol users and control group, and frequency and quantity of alcohol consumption were not associated with any measure of the IST. In the DW condition, there was no significant difference in IST performance across each group, indicating that the altered reward schedule may override a tendency to engage in impulsive decision making, even in those exhibiting lower levels of reflection. Findings provide further support that cannabis users exhibit an impaired ability to gather and evaluate information prior to decision making.

Taken together, the findings of Clark et al. (2006), Clark et al. (2009), and Solowij et al. (2012) provide preliminary evidence that cannabis, opiate, and amphetamine users each display impulsive patterns of decision making that are characterised by reduced information sampling, and greater decisional inaccuracy. It is possible that poor reflection, and impulsive patterns of decision making are prevalent across a variety of substance users, which may place these cohorts at greater risk of continued drug use and dependence. However, given IST
In support of the argument that reflection-impulsivity may represent a vulnerability marker of addiction, Lawrence et al. (2009) hypothesised that problem gamblers and alcohol dependent males would experience an overlap in impaired reflection-impulsivity. In this study, problem gamblers \((n = 21)\), alcohol dependent \((n = 21)\) and control \((n = 21)\) groups completed a battery of cognitive tasks, including the IST, to compare the neurocognitive profiles of these cohorts. Study findings supported the hypotheses, where the problem gamblers and alcohol dependent groups each displayed impaired performance on the IST. Specifically, both groups opened fewer boxes, and tolerated significantly more uncertainty in their decisions compared to the control group. Importantly, the study findings indicate that lower levels of reflection may relate to a premorbid vulnerability to addiction, given problem gamblers who are unlikely to experience neurobiological impairment following chronic alcohol abuse, exhibited the same pattern of performance to that of dependent drinkers.

Expanding on the aforementioned studies, Caswell, Morgan, and Duka (2013) applied experimental techniques to evaluate the acute effects of alcohol on reflection-impulsivity in a student sample \((n = 48)\). Performance on a battery of cognitive and motor tasks, including the IST, was compared among participants who consumed either a high dose (0.8 grams per kilogram) or low dose (0.4 grams per kilogram) of alcohol. In this study, the pharmacological effects of
alcohol had no effect on IST performance; however, alcohol impairment expectancies did elicit an effect on IST performance. Specifically, those who expected a greater level of impairment following alcohol consumption exhibited greater levels of reflection on the IST, potentially in attempt to compensate for the expected behavioural impairment associated with alcohol intoxication. This is consistent with Fillmore and Blackburn (2002) who found that participants exhibit compensatory behaviours on cognitive tasks when expecting to receive alcohol. This pattern of results indicates that reflection-impulsivity appears to be unaffected by the acute effects of alcohol, however, cognitive factors such as expectations may alter decisional performance.

Overall, the findings from Clark et al. (2006), Clark et al. (2009), Solowij et al. (2012), and Lawrence et al. (2009) indicate that substance users, gamblers, and those with alcohol addiction are likely to make impulsive decisions characterised by less consideration of all available information and greater inaccuracy. Clark et al. (2006) and Lawrence et al. (2009) suggest that deficits in reflection-impulsivity displayed by these cohorts may be related to pathophysiology of the prefrontal cortex. Thus, it is possible that impaired performance on the IST may reflect impairments accumulated in the prefrontal regions following chronic drug exposure. However, research by Lawrence et al. (2009) suggests that these decisional patterns may act as a predisposing risk factor in the development of addiction behaviour, rather than resulting from neurophysiological damage due to chronic alcohol abuse. As such, it is unclear whether patterns of reflection relate to a premorbid vulnerability or result from chronic alcohol or drug abuse.
Reflection-Impulsivity in Binge Drinkers

More recently, a series of empirical studies have investigated reflection-impulsivity in samples of binge drinkers without issues of addiction, in order to understand how patterns of reflection may manifest in non-clinical, young drinkers. At present, three studies have examined reflection-impulsivity samples of binge drinkers (Banca et al., 2015; Bø et al., 2016; Townshend et al., 2014).

First, Townshend et al. (2014) compared IST performance among low- and high-binge drinkers ($n = 92$). The Alcohol Use Questionnaire (Townshend & Duka, 2002) was utilised as a measure of binge drinking, participants were split into either high-binge ($n = 46$) or low-binge ($n = 46$) groups based upon their binge drinking score. In this study, the high-binge group displayed lower levels of reflection compared to the low-binge drinkers, as participants opened fewer boxes, scored a lower probability of making correct choice, and made more errors in the FW condition. In the DW condition, there was no difference in IST performance among high- and low-binge drinkers. This pattern of results is highly significant, as they indicate a sample of young binge drinkers, with no history of chronic drug or alcohol abuse, exhibit similar patterns of reduced information sampling, and greater decisional inaccuracy, to that observed in chronic drug users and gamblers Clark et al. (2006), Clark et al. (2009), Lawrence et al. (2009), and Solowij et al. (2012).

Banca et al. (2015) sought to expand findings of Townshend et al. (2014) by investigating levels of reflection in a sample of young binge drinkers ($n = 30$) and healthy volunteers ($n = 30$). Binge drinkers were identified as those who consumed five or more drinks for males, and four or more drinkers for females within a two-hour period, at least once a week for the last three months.
Reflection-impulsivity was assessed using the IST, and a conceptually similar task, the beads task (Huq, Garety, & Hemsley, 1988). The beads task is a computerised behavioural measure where subjects decide which jar a bead is being selected from based on the successive viewing of coloured beads. Inconsistent with the hypotheses, performance on the IST did not significantly differ between the binge drinkers and healthy volunteers in the FW condition. Further, binge drinkers demonstrated an improved capacity to integrate information by earning significantly greater points in the DW condition, compared to healthy volunteers. Interestingly, binge drinkers displayed reduced information sampling on the beads task, by selecting significantly fewer beads compared to healthy volunteers. Although the IST and beads task are conceptually similar (Banca et al., 2015), there was no significant correlation between boxes opened the IST and beads drawn in the beads task. Similar findings are reported by Balzan, Ephraums, Delfabbro, and Andreou (2016), where the beads task and the box task, a behavioural measure vastly similar to the IST, were unrelated. Thus, it appears that the IST and beads task may be measuring unrelated constructs, and as such, utility of the beads task as a measure of reflection-impulsivity is unclear.

Finally, Bø et al. (2016) utilised hierarchical regression analysis to examine the contribution of binge drinking in the prediction of IST performance while controlling for general executive functioning and substance use. Consistent with Townshend et al. (2014), binge drinking was assessed using the AUQ in a sample of students ($n = 121$), however, participants were not split into high- and low-binge groups. In this study, binge drinking significantly predicted performance on the IST in the DW condition, however, it did not predict
performance in the FW condition. Specifically, greater levels of binge drinking predicted a lower probability of making a correct choice at the point of decision; although, only in the context of a reward contingency. Interestingly, general executive functioning was not significantly predicted by binge drinking, nor was it associated with reflection-impulsivity. This pattern of results suggests that binge drinkers’ performance may have been driven by a hypersensitivity to reward. Specifically, it appears that higher level binge drinkers prioritised positive consequences, namely, winning points on the IST, and were insensitive to the probability of making an incorrect decision.

Overall, the findings from Townshend et al. (2014), Banca et al. (2015), and Bø et al. (2016) provide inconsistent information about the reflective patterns of young binge drinkers. Thus, it remains unclear whether binge drinkers exhibit lower levels of reflection when making decisions. Although Townshend et al. (2014) and Bø et al. (2016) each report links between binge drinking and poor reflection, these studies differ in terms of the IST reward contingency that elicited a significant result.

The reward condition is highly relevant to performance on the IST and thus, interpretation of performance across task conditions vary. Specifically, the FW condition places no restrictions on information sampling, as participants are able to open as many boxes as they like without losing points. As such, those who do not open all boxes are suggested to display poorer reflection and impulsive decision making, as they are not penalised for opening each box within the matrix. In contrast, the DW condition places a penalty of 10 points for each box opened in the matrix and thus, those motivated by winning points are prompted to sample less information within this condition. As such, it appears that high-binge
drinkers in Townshend et al. (2014) exhibited impulsive decisional patterns, by sampling less information despite the absence of a penalty, whilst binge drinkers in Bø et al. (2016) exhibited a greater sensitivity to the rewarding aspects of the task, by sampling less information at the point of decision, in order to maximise the total number of points earned.

Due to the cross-sectional nature of the aforementioned studies, it is unclear whether patterns of reflection are a product of chronic substance misuse or binge episodes, or if they are driven by an underlying impulsive disposition. Interestingly, the IST has largely been studied in isolation of personality frameworks, with the exception of Clark et al. (2006), Caswell et al. (2013), and Clark et al. (2009). Specifically, studies investigating associations between reflection-impulsivity and impulsive personality have utilised the BIS-11 (Caswell et al., 2013; Clark et al., 2006), and the Impulsiveness- Venturesomeness-Empathy (IVE) questionnaire (Clark et al., 2009), and found no significant links between levels of reflection and the BIS-11 or IVE. However, given a series of studies argue that patterns of reflection are likely to represent a premorbid vulnerability to addiction (i.e., Clark et al., 2006; Clark et al., 2009; Lawrence et al., 2009), and preliminary evidence suggests binge drinking is linked to impulsive decisions driven by reward sensitivity (Bø et al., 2016), it is possible that further exploration of reflection-impulsivity within the context of personality may help identify underlying factors that contribute toward impulsive patterns of decision making.

It is therefore argued in this thesis that investigation of reflection-impulsivity together with rash impulsiveness and reward sensitivity may provide unique insights into the personality and cognitive processes that drive binge
drinking behaviour. As discussed in Chapter Two, the two-factor model is well established in the field of substance and alcohol misuse, and exploration of cognitive mechanisms within this model have provided important insight into how an impulsive personality drives alcohol misuse. Despite this, previous studies have not investigated the two-factor model together with reflection-impulsivity. Thus, it is argued that elevations in rash impulsiveness and reward sensitivity may lead to impulsive decisional patterns, which may drive binge drinking behaviour. Further, it is possible that reflection-impulsivity may elicit greater influence over the binge pattern of drinking compared to that of the two-factor model. This argument is made as decision-making patterns are likely to have a proximal effect on the choices young people make about binge drinking, whereas rash impulsiveness and reward sensitivity are more likely to play a distal role within this context.

Summary

Taken together, empirical evidence suggests that substance using, alcohol addicted, and gambling cohorts each display impairments in the ability to gather and evaluate information prior to decision making (Clark et al., 2006; Clark et al., 2009; Lawrence et al., 2009; Solowij et al., 2012). However, it is unclear whether impairments in reflective decisional patterns precede, or follow hazardous patterns of alcohol and substance misuse. In the context of binge drinking, inconsistent study findings indicate that further research is needed to understand the decisional patterns of young binge drinkers. As such, evaluation of additional factors may help explain, or understand how impulsivity relates to binge drinking behaviour in young people.
It is argued in this thesis that evaluation of reflection-impulsivity together with the two-factor model may provide a new perspective into how levels of reflection interact with an impulsive personality, and drive drinking behaviour. Moreover, evaluation of additional risk and protective factors in young binge drinkers may build upon this framework, to delineate between those who remain social binge drinkers, and those who are at risk of developing more problematic patterns of misuse. Thus, the following chapter will examine the role of risk taking and trait-mindfulness together with impulsivity, in the prediction of binge drinking, and discuss how these factors may promote, and protect against binge drinking behaviour in young people.
CHAPTER FOUR

Risk and Protective Factors of Alcohol Misuse

Overview

Chapters Two and Three discussed the well-established role of impulsivity in hazardous alcohol and substance misuse, and highlighted the importance of integrating impulsive theory across multiple domains and modalities. Further, the role of cognitive mediators that help explain the impulsivity – alcohol use relationship was discussed.

The present chapter aims to build upon this discussion by exploring the role of additional risk and protective factors that may contribute to the understanding of how an impulsive profile influences drinking behaviour. Specifically, a series of studies indicate that the tendency to take risks is associated with greater levels of drinking, whilst trait-mindfulness is linked with lower and more adaptive forms of drinking behaviour (Adams et al., 2013; Fernie, Cole, Goudie, & Field, 2010; Fernie et al., 2013; Murphy & MacKillop, 2012). Investigation of these factors may identify additional correlates of impulsivity that may delineate social drinkers from those who are at risk of addiction. It will be argued in this chapter that risk taking and trait-mindfulness may be important variables that help explain the impulsivity – alcohol use relationship.

Risk Taking

Conceptualisation and Methodology

Risk taking is characterised as behaviour intended to attain a desired reward with the potential for an undesirable result such as loss, danger, or harm
Evidence suggests there is a general risk-taking disposition that is relatively stable across time, where individuals vary in their tendency to be risk takers or risk averse (Hansen & Breivik, 2001; Highhouse, Nye, Zhang, & Rada, 2016). However, it appears the tendency to take risks is also influenced by context (Highhouse et al., 2016). For example, patterns of risk taking may vary across a variety of situations, such as financial decision making, sporting pursuits, interpersonal aggression, use of alcohol or substances, social behaviour, sexual activity, and driving (Boyer, 2006; Highhouse et al., 2016).

Given risk taking occurs across a variety of contexts, there is considerable variability in the way that risk taking is measured. Predominantly, measurement of risk taking falls into two areas, the first includes behavioural measures that provide a controlled assessment of actual risk-taking behaviour (e.g., Bechara et al., 1994; Lejuez et al., 2002), and the second includes self-report measures of risk taking, that generally include an assessment of previous engagement in risky behaviour (Gullone, Moore, Moss, & Boyd, 2000), an assessment of how likely a participant would engage in a series of risky behaviours, or perceptions about a series of risk behaviours (e.g., Weber, Blais, & Betz, 2002). Given the significant diversity of risk taking behaviour, it is recommended by Aklin, Lejuez, Zvolensky, Kahler, and Gwadz (2005) that a multimethod approach be used in order to capture the multidimensional nature of risk taking.

A widely used behavioural measure of risk taking is the Balloon Analogue Risk Taking Task (BART; Lejuez et al., 2002). The BART examines actual risk-taking behaviour through the balancing of reward and loss on a computer-generated gambling task. The task includes a number of trials where participants pump a simulated balloon. Money or points are awarded for each pump; however,
the balloon may burst at any time resulting in the loss of points or money earnt on that trial. Performance on the BART predicts real world risk taking behaviour, such as smoking, alcohol and substance misuse, gambling, and theft (Aklin et al., 2005; Fernie et al., 2010; Lejuez et al., 2003).

A self-report measure of risk taking that is emerging in the literature is the Domain Specific Risk-Taking Scale (DSRT; Weber, Blais, & Betz, 2002). This measure provides an assessment of risk-taking across five life domains, including financial decisions, health and safety, recreational, ethical, and social decisions. This measure was developed based on the argument that risk-taking can vary across a variety of contexts or situations, and has been shown to predict actual risk-taking behaviour including smoking, problem drinking, cannabis use, and financial risks (Gilman, Calderon, Curran, & Evins, 2015; Markiewicz & Weber, 2013; Szrek, Chao, Ramlagan, & Peltzer, 2012). Together, the BART and the DSRT each provide an assessment of risk taking from multiple perspectives, and allow for the prediction of risk taking behaviours that take place in daily life.

**Risk taking and Impulsivity**

As discussed in Chapter Two, research investigating the role of impulsivity in alcohol misuse identifies a number of cognitive variables that mediate the impulsivity – alcohol misuse relationship (Gullo et al., 2010a; Harnett et al., 2013; Kabbani & Kambouropoulos, 2013). This line of research indicates that it is not only important to evaluate the role of impulsivity within alcohol use behaviour, but to also investigate relevant cognitive and behavioural factors to explain how elevations in impulsivity may lead to hazardous alcohol and substance misuse. As such, it is argued that investigation of the relationships between an impulsive temperament, risk-taking, and binge drinking, may provide
novel insights into how an impulsive personality influences patterns of alcohol misuse.

Conceptually, there is an overlap between the constructs of risk taking and impulsivity. For example, both encompass participation in behaviour with little regard for negative consequences (Bornovalova et al., 2009), and neurologically, each stem from functioning of the prefrontal cortex (Steinberg et al., 2008). Neurobiological studies indicate that risk-taking is related to reward-related activation of the medial prefrontal cortex and the ventral striatum, as well as patterns of connectivity between these regions (Lee & Jeong, 2013; van Duijvenvoorde et al., 2014). Greater risky decisions or behaviour are associated with activation of the ventral striatum, the medial prefrontal, dorsolateral prefrontal, lateral orbitofrontal, and superior parietal cortices (van Duijvenvoorde et al., 2014; Worbe et al., 2014). As discussed in Chapter Two, functioning of the prefrontal regions are implicated in the expression of impulsivity at the trait and behavioural level (Crews & Boettiger, 2009; Horn et al., 2003; Lyvers et al., 2012).

Despite the conceptual and neurobiological overlap with impulsivity, risk taking is not always impulsive. For example, engagement in risky behaviour may also be deliberate, based upon consideration of the potential costs versus benefits (Maslowsky, Keating, Monk, & Schulenberg, 2011). Given risk taking can be both impulsive, and pre-determined, it is argued that this construct is distinct, although related to impulsivity. As such, it is possible that risk taking may play an important role within the impulsivity – alcohol use relationship.
Recently, empirical research indicates that risk taking is related to both rash impulsiveness and reward sensitivity (Maher, Thomson, & Carlson, 2015; Romer et al., 2016; Wood, Dawe, & Gullo, 2013). For example, Romer et al. (2016) explored the utility of rash impulsiveness and reward sensitivity in the prediction of risky behaviour in a sample of students ($n = 899$). In this study, risk taking was measured using the Adolescent Risk Questionnaire (ARQ; Gullone et al., 2000) and responses were grouped into either maladaptive or adaptive forms of risk taking. Maladaptive risk taking was identified as prevalence of alcohol and drug use, tobacco smoking, drink driving, and unsafe sexual behaviour. Whilst adaptive risk taking was defined by engagement in a series of sporting activities and entry into competitions. In this study, rash impulsiveness was exclusively related to maladaptive forms of risk taking, where greater rash impulsiveness predicted higher levels of alcohol and drug use, and risky sexual behaviour. Reward sensitivity was associated with both adaptive and maladaptive forms of risk behaviour, where greater reward sensitivity predicted higher rates of alcohol and drug use, engagement in sporting activities and entry into competitions. The study findings suggest that like alcohol use, the two-factor model appears to differentially relate to patterns of risk taking in young people (Romer et al., 2016). Moreover, the pattern of results indicate that rash impulsivity may relate specifically to problematic risk behaviour, whilst reward sensitivity may predict risk taking across a broader range of adaptive and maladaptive behaviour.

Similarly, Thomson and Carlson (2014b) and Maher et al. (2015) evaluated the role of reward sensitivity and rash impulsiveness in the engagement of risky sports (downhill skiing and snowboarding) in a sample of undergraduate students ($n = 279$). Principal component analysis was conducted on a series of
impulsivity measures, including the SPSRQ (Torrubia et al., 2001), the BIS/BAS scale (Carver & White, 1994), the International Personality Item Pool 50-item Big Five Instrument (IPIP; Goldberg et al., 2006), the ZKPQ Impulsive Sensation Seeking Scale (ImpSS; Zuckerman, Kuhlman, Joireman, Teta, & Kraft, 1993) and the UPPS-P Impulsive Behaviour Scale (Whiteside & Lynam, 2001). From these measures, three components emerged. The first was reward sensitivity, comprised of BAS-Drive, BAS-Fun Seeking, BAS-Reward Responsiveness, Sensitivity to Reward, and Extraversion subscales. The second component, rash impulsiveness, included high Conscientiousness, high Premeditation, high Perseverance, Positive Urgency, Negative Urgency, Z-Imp, Z-Sensation Seeking subscales. The final component was punishment sensitivity, which included low extraversion, BIS, low UPPS-P Sensation Seeking, Neuroticism, and Sensitivity to Punishment subscales. Two-way analysis of variance indicated that those who engaged in either skiing or snowboarding reported significantly greater reward sensitivity and low punishment sensitivity, compared to those who did not participate in downhill sports (Thomson & Carlson, 2014b). Interestingly, there was no difference in participant scores for rash impulsiveness between sporting and non-sporting groups.

Follow-up regression analyses of those who identified as proficient skiers or snowboarders \((n = 123; \text{Maher et al., } 2015)\) found that those with elevations in the rash impulsiveness factor reported greater levels of risk taking whilst engaged in either skiing or snowboarding (Maher et al., 2015). In contrast, the reward sensitivity factor did not significantly predict greater sport related risk-taking behaviour. Together, these findings suggest that while reward sensitivity may lead to greater participation in risky sports, it does not appear to elevate risk taking
during sport engagement. Conversely, the results indicate that while rash impulsiveness did not lead to greater engagement in risky sports, it was linked to greater levels of risk taking once engaged in a particular sport (Maher et al., 2015; Thomson & Carlson, 2014b). Together, the study findings indicate that patterns of rash impulsiveness and reward sensitivity may manifest in a similar way to that observed in alcohol and substance misuse. Specifically, it appears that reward sensitivity is linked to general risk-taking behaviour, while rash impulsiveness is linked to elevated and more hazardous forms of risky behaviour. These patterns will be discussed in more detail below.

Finally, Wood et al. (2013) investigated the interrelationships between prosocial risk taking, reward sensitivity, rash impulsiveness, and substance use in a sample of high school students \( n = 969 \). Prosocial risk taking included participation in sport or extracurricular activities that had the potential for physical, or emotional consequences, including rugby, netball, surfing, public speaking, dancing, or singing. Using structural equation modelling techniques, findings indicated that reward sensitivity was associated with greater engagement in prosocial risk-taking behaviour, and that engagement in activities with potential physical risks mediated the association between reward sensitivity and substance use. Interestingly, rash impulsiveness was associated with less engagement in activities with potential emotional risks, and there was no significant association between rash impulsiveness and engagement in physical risk activities. The findings align with Thomson and Carlson (2014b) and Maher et al. (2015) by indicating that rash impulsiveness and reward sensitivity play a differential role in risk taking behaviour, and that reward sensitivity is strongly linked to prosocial risk behaviours such as sporting ventures. Further, it appears that engagement in
risk taking activities may act as a potential risk factor in substance use in adolescents, despite being prosocial in nature.

Taken together, it appears that individual differences in impulsivity may influence the tendency to engage in risky behaviour. The pattern of results reported by Romer et al. (2016), Maher et al. (2015) and Wood et al. (2013) indicate that reward sensitivity appears to drive greater prevalence across risk taking behaviours that are both prosocial or considered harmful. In contrast, it appears rash impulsiveness is less predictive of participation in risk activities but instead, drives greater risk taking within certain behaviours. This pattern is comparable to that of the two-factor model in the context of alcohol and substance misuse. Specifically, while reward sensitivity is associated with earlier onset of alcohol use, it is less consistently related to hazardous or risky forms of alcohol use. On the other hand, rash impulsiveness is associated with higher-risk substance use, and greater quantity of substance use (Gullo et al., 2014). Given the similarity of these patterns, it is argued that risk taking behaviour may be highly relevant in the understanding of how impulsivity drives alcohol misuse.

**Risk Taking and Alcohol Misuse**

In addition to impulsivity, risk taking has also been explored for its role in alcohol misuse and binge drinking. At present, the current body of research indicates that risk taking is likely to both precede, and be perpetuated by alcohol use (de Haan et al., 2015; Fernie et al., 2013; Miller et al., 2007). Specifically, prevalence studies investigating risk taking in young people suggest that young binge drinkers, identified as those who consumed five or more alcoholic drinks over a two-hour period, are more likely to engage in health risk behaviours
compared to non-binge drinkers (Miller et al., 2007; Stickley, Koyanagi, Koposov, Razvodovsky, & Ruchkin, 2013).

Further, a prevalence study in high school students ($n = 15,214$) reported that binge drinkers exhibited higher rates of risky behaviour, such as riding with a driver who had been drinking, engaging in risky sexual behaviour, smoking cigarettes, use of illicit substances, and engagement in physical violence, compared to non-binge drinkers (Miller et al., 2007). Similar findings were reported by Stickley et al. (2013), who found adolescent binge drinkers reported greater rates of risky behaviour including use of substances, risky sexual behaviour, and violence, when compared to non-binge drinkers. Together, these studies indicate that there appears to be a consistent link between the prevalence of binge drinking and elevations in risky behaviour.

In addition, a series of studies indicate that the disposition to take risks may also predict elevated alcohol use in young cohorts (de Haan et al., 2015; Fernie et al., 2010; Fernie et al., 2013). For example, de Haan et al. (2015) investigated the relationship between risk taking behaviour, alcohol use, and binge drinking, in a sample of university students ($n = 6002$). Risk taking was measured with the Risk Taking Questionnaire (RT-18 (de Haan et al., 2011) and the Quick Drinking Screen (Sobell et al., 2003) provided a measure of alcohol consumption and binge drinking. Logistic regression analyses indicated that self-reported risk taking was significantly related to alcohol use and binge drinking, whilst age, lifestyle, depression, anxiety, and stress were controlled for. This pattern of results indicates that those who reported a greater tendency to take risks were more likely to binge drink, compared to those who were risk averse.
Building on these findings, Fernie et al. (2010) explored the utility of risk taking and trait impulsivity in the prediction of alcohol use in young social drinkers \((n = 75)\). Risk-taking was measured by the BART (Lejuez et al., 2002), behavioural measures of impulsivity included the Go/No-Go task (Miller et al., 1991), Delay Discounting Task (Du, Green, & Muerson, 2002), and the Stop Task (Fillmore & Vogel-Sprott, 1999). Self-reported impulsivity was measured with the BIS-11 (Patton, Stanford, & Barratt, 1995). In this study, elevated risk taking on the BART significantly predicted higher levels of alcohol use, accounting for 5\% of the variance; while self-reported BIS non-planning impulsivity accounted for 8\% of the variance in alcohol use. Interestingly, none of the behavioural impulsivity measures significantly predicted alcohol use. This pattern of results indicates that although risk taking and impulsivity are related constructs, each play an important role in patterns of alcohol misuse.

Finally, the tendency to take risks has been shown to predict alcohol use six months later (Fernie et al., 2013). A prospective study evaluating the predictive relationship of risk taking, as measured by the BART (Lejuez et al., 2002), reported that risk-taking behaviour significantly predicted greater quantity and frequency of alcohol consumption, in a large sample of adolescents \((n = 287)\). This pattern of results was observed across three out of four time-points, over a period of two-years. As such, it appears that risk taking behaviour plays an important and unique role in drinking behaviour, and can predict patterns of alcohol use six months later.

The study findings reported in de Haan et al. (2015), Fernie et al. (2010), and Fernie et al. (2013) indicate that risk taking and trait impulsivity each play a unique role in the prediction of alcohol misuse and binge drinking. Given the
conceptual and neurobiological links between risk taking and impulsivity, it is possible that elevations in an impulsive personality may enhance the tendency to take risks, which may in turn lead to greater alcohol misuse and binge drinking. Although preliminary evidence suggests that risk taking may mediate the relationship between impulsivity and substance use (Wood et al., 2013), further evidence is needed to provide support for this finding.

**Summary**

Taken together, it is argued in this thesis that the tendency to take risks may act as a significant risk factor in alcohol misuse and binge drinking. The studies reviewed in this chapter indicate that there is a consistent link between risk-taking behaviour and elevations in alcohol use and binge drinking, and that this pattern is consistent, regardless of whether the risk behaviour is maladaptive, prosocial, or adaptive. Further, it is argued that elevations in risky behaviour may be driven by an impulsive personality, and that rash impulsiveness and reward sensitivity may play a differential role in risky patterns of behaviour. As such, the present thesis aims to explore the interrelationships between risk taking, impulsivity, and binge drinking.
Exploring Mindfulness as a Protective Factor

Overview

It is important not only to consider risk factors in the development of hazardous alcohol misuse. Protective factors provide equally important clinical implications in the development of prevention and treatment interventions. As such, the following section will explore the protective role of mindfulness in binge drinking behaviour. A series of studies that investigate mindfulness in alcohol use and binge drinking will be reviewed and discussed in the context of impulsivity and decision-making patterns. It will be argued that mindfulness may act as a protective factor against binge drinking behaviour through reflective patterns of decision making and regulation of impulsive behaviour.

Mindfulness

Conceptualisation

Mindfulness is defined as the ability to focus attention on the present moment with an attitude that is non-judgmental and accepting of the present moment experience (Kabat-Zinn, 2003; Peters et al., 2011). Mindfulness is unique as it may occur naturally as a trait, and can also be cultivated through the practice of meditation (Baum et al., 2010; Brown & Ryan, 2003). Trait mindfulness refers to the tendency to naturally engage in mindful practice, such as attending to the present moment in a non-judgemental or reactive way (Brown, Ryan, & Creswell, 2007; Garland, 2007), and is associated with greater self-compassion, emotion regulation, lower levels of stress and neuroticism (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006).
Empirical studies indicate that the disposition to be mindful is modifiable, and can be enhanced through the practice of mindfulness-based interventions (Carmody & Baer, 2008). Mindfulness-based interventions typically include practices such as mindfulness meditation and experiential exercises that direct attention toward thought, emotion, or senses, whilst encouraging acceptance (Brown et al., 2007). Mindfulness-based interventions have received considerable attention, resulting in the development of multiple clinical interventions that incorporate mindful techniques, such as Mindfulness-Based Stress Reduction (Kabat-Zinn, 1984), Mindfulness-Based Cognitive Therapy (Segal, Williams, & Teasdale, 2002), Acceptance and Commitment Therapy (Hayes, Strosahl, & Wilson, 1999), and Dialectical Behaviour Therapy (Linehan, 1993). These interventions have grown in popularity and are efficacious in improving a variety of presenting issues, including reductions in stress, symptoms of depression, anxiety, chronic pain, as well as disorders related to impulse control such as binge eating, substance and alcohol use (Godfrey, Gallo, & Afari, 2015; Lenz, Hall, & Smith, 2016; Li, Howard, Garland, McGovern, & Lazar, 2017; Veehof, Trompetter, Bohlmeijer, & Schreurs, 2016; Vøllestad, Nielsen, & Nielsen, 2012).

Measures of mindfulness utilised in empirical literature are predominantly self-report in nature, and typically provide an assessment of mindfulness as either a unidimensional (Brown & Ryan, 2003), or multi-dimensional construct (Baer, Smith, & Allen, 2004; Baer et al., 2006). A commonly used measure of mindfulness is the Kentucky Inventory of Mindfulness Skills (KIMS; Baer et al., 2004). The KIMS is a self-report measure that assesses the general tendency to be mindful in daily life. Mindfulness is evaluated across four key mindful skills: observing or attending to internal and external stimuli, describing or labelling
observed phenomena without conceptual analysis, acting with awareness or actively attending to one thing at a time, and accepting present moment experiences in a nonevaluative or judgemental way (Baer et al., 2004). These mindful domains were derived from the behavioural descriptions of mindfulness developed by Linehan (1993) in the development of Dialectical Behaviour Therapy. The KIMS can be used to assess trait mindfulness in meditation-naive populations, and is also sensitive to detect change in skills, following the practice of mindfulness-based training (Baum et al., 2010).

**Mindfulness, Impulsivity, and Alcohol Use**

Like risk taking, mindfulness shares conceptual similarities to impulsivity. Specifically, both mindfulness and impulsivity are oriented in the present moment, however, the way each construct presents is qualitatively different (Murphy & MacKillop, 2012). For example, mindfulness reflects an awareness and observation of the present without judgment or reactivity, whereas impulsivity reflects an emphasis on the immediate moment, characterised by reactive behavioural responses without consideration of potential consequences or alternate courses of action (Marlatt, 2002; Murphy & MacKillop, 2012). As such, a growing body of research indicates that there is an inverse relationship between naturally occurring trait-mindfulness and impulsivity (Brown & Ryan, 2003; Peters et al., 2011).

This was demonstrated by Peters et al. (2011), who investigated the relationship between trait-mindfulness and impulsivity in a sample of university students ($n = 347$). Trait-mindfulness was measured using the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003), and the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006), whilst the Barratt Impulsiveness Scale
(BIS-11; Patton et al., 1995) provided a measure of impulsivity. In this study, trait mindfulness was negatively correlated with attentional \( (r = -.47) \), motor \( (r = -.37) \), and non-planning impulsivity \( (r = -.23) \). Specifically, those who reported a greater tendency to act with awareness and describe their experiences without judgement, reported lower levels of impulsivity across multiple domains. The small to moderate correlations that emerged among mindful and impulsive domains indicates that although related, mindfulness and impulsivity are distinct constructs.

Similarly, Murphy and MacKillop (2012) reported an inverse relationship between mindfulness and impulsivity in a sample of students \( (n = 116) \). In this study, trait impulsivity was measured by the UPPS-P Impulsivity Scale (Whiteside & Lynam, 2001) and the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006) provided a measure of trait mindfulness. Correlational analyses indicated that greater mindful awareness was linked to lower levels of sensation seeking, premeditation, and lack of perseverance. Interestingly, sensation seeking was positively associated with mindful observing, suggesting that those who are motivated by seeking exciting experiences may be more experientially aware of sensations, thoughts, and feelings (Murphy & MacKillop, 2012). Together with findings reported in Peters et al. (2011), the pattern of results indicates that those who display a natural disposition to attend to present moment experiences in a non-evaluative or judgemental way are less likely to act impulsively across a variety of impulsive domains.

Given links between trait-mindfulness and impulsivity, recent clinical work identifies mindfulness as a potential mechanism that underpins the association between impulsivity and alcohol related outcomes (Chiesa, Calati, &
Serretti, 2011; Leeman, Bogart, Fucito, & Boettiger, 2014). At present, evidence appears to support the efficacy of mindfulness-based interventions in improving treatment outcomes for alcohol and substance using cohorts (Staiger, Dawe, Richardson, Hall, & Kambouropoulos, 2014; Witkiewitz, Marlatt, & Walker, 2005). For example, Staiger et al. (2014) examined the relationships between impulsivity, mindfulness, and drug dependence in a sample of treatment seeking drug users (n = 144). Following five mindfulness-based sessions, improvements in mindfulness skills, as measured by the KIMS, were associated with better treatment outcomes at three months’ post-treatment. Importantly, mindfulness was negatively associated with impulsivity; however, the level of impulsivity did not impact upon the extent to which participants improved in mindful awareness and acceptance (Staiger et al., 2014). This suggests that an impulsive personality may not prevent the ability to develop and practice mindful based skills in daily life.

Findings reported by Staiger et al. (2014) provide support for the argument that mindfulness may be an important domain within the impulsivity – alcohol misuse relationship. It is argued by Stratton (2006) that the tendency to observe present moment experiences in a nonevaluative way may strengthen an individual’s ability to detach from emotions, cues, or motivations, before automatic behaviour is initiated. As such, it is possible that mindful processes may be particularly relevant for the rash impulsive and reward sensitive individual, where approach behaviour driven by motivation for alcohol, may be observed rather than acted on, and the ability to direct attention and perform behaviour in a purposeful way, may regulate the tendency to engage in rash, unconsidered behaviour.
Although these processes have not specifically been explored, there is evidence to suggest that mindfulness plays an important role in modifying the relationship between automatic alcohol related motivation and actual alcohol behaviour (Ostafin, Kassman, & Wessel, 2013; Ostafin & Marlatt, 2008). For example, Ostafin and Marlatt (2008) investigated whether mindfulness moderated the relationship between automatic implicit alcohol motivation and actual alcohol behaviour. In this study, a sample of undergraduate students \( n = 50 \) completed the KIMS (Baer et al., 2004), a measure of hazardous drinking (identified as five or more alcoholic drinks for males, and four or more drinks for females), and a measure of automatic alcohol motivation using the Implicit Association Test (Draine, 2004; Greenwald, McGhee, & Schwartz, 1998). Moderation analysis indicated that the mindfulness domain acceptance significantly moderated the relationship between implicit alcohol motivation and hazardous drinking. Specifically, the tendency to accept experiences without judgement or evaluation weakened the association between automatic alcohol-approach motivation and hazardous drinking.

Building on these findings, Ostafin et al. (2013) investigated the moderating role of mindfulness on the relationship between automatic alcohol-valence associations and preoccupation with alcohol-related thoughts. Sixty-one undergraduate students completed the FFMQ (Baer et al., 2006), a measure of hazardous drinking (identified as five or more alcoholic drinks for males, and four or more drinks for females), the Temptation and Restraint Inventory (Collins & Lapp, 1992), and a measure of automatic alcohol motivation using the Implicit Association Test (Draine, 2004; Greenwald et al., 1998). In this study, trait-mindfulness was significantly associated with lower preoccupation with alcohol-
related thoughts, and significantly moderated the relationship between automatic alcohol approach responses and alcohol preoccupation. This indicates that elevations in trait-mindfulness weakened the relationship between automatic alcohol-valence associations and alcohol preoccupation.

Together, these studies highlight that mindfulness plays an important role in regulating the relationship between alcohol-related stimuli and automatic behaviour. As such, it is possible that mindfulness may play an equally important role in regulating binge drinking behaviour associated with rash impulsiveness and reward sensitivity. It is possible that the way in which trait-mindfulness may weaken the association between impulsivity and binge drinking may relate to an enhanced capacity to reflect during the decision-making process. It is argued that processes of mindfulness such as attention, resistance to distraction, and cognitive control, may relate to the reflective component of reflection-impulsivity, which may be linked to more adaptive drinking behaviour.

At present, only one study has investigated the role of mindfulness together with the decisional patterns related to reflection-impulsivity. Specifically, Valls-Serrano, Caracuel, and Verdejo-Garcia (2016) evaluated a mindfulness-based intervention on reflection-impulsivity and executive functioning in a sample of polysubstance users in residential treatment ($n = 32$). In this study, participants completed an eight-week mindfulness-based intervention or treatment as usual. Results indicated that, compared to the control group, those who received the mindfulness-based intervention displayed significantly greater improvements in working memory, achievement of daily goals, and planning ability. Importantly, those who received the mindfulness-based intervention exhibited greater levels of reflection post-intervention, by
sampling more information and making less errors on the IST, while the control group displayed no changes in performance on the IST at follow up. This pattern of results indicates that the mindful practice of focusing attention on the present moment may enhance reflective capacity and adaptive decisional patterns. These findings highlight the relevance of mindful processes in reflective patterns of decision making. However, given this is the first study to investigate mindfulness and reflection-impulsivity together, further research in this area is needed.

The aforementioned studies provide important insights into how mindful attention and acceptance may relate to impulsivity and protect against hazardous drinking and substance misuse. Although these processes have received little evaluation specifically in binge drinkers, it is likely that these processes are relevant within a binge drinking population. In line with the above studies, preliminary research suggest that mindfulness is associated with patterns of drinking that are more adaptive (Adams et al., 2013; Mermelstein & Garske, 2015). For example, Adams et al. (2013) evaluated trait-mindfulness as a potential mechanism to reduce problematic alcohol use and binge drinking, in a sample of African American smokers \(n = 399\). Trait mindfulness was evaluated using the MAAS, and the Alcohol Quantity and Frequency Questionnaire (Sobell et al., 2003) provided a measure of binge drinking. Path analytic techniques indicated that greater dispositional mindfulness was associated with fewer drinks consumed per week, fewer binge episodes in the past three months, and a reduced likelihood of an alcohol use disorder.

Further, Mermelstein and Garske (2015) evaluated the efficacy of a four-week mindfulness-based intervention in reducing rates of binge drinking in university students \(n = 76\). In this study, those who engaged in the mindful
intervention reported significantly less episodes of binge drinking, fewer negative consequences of alcohol use, higher alcohol refusal self-efficacy, and higher dispositional mindfulness, compared to the control group. Importantly, there was no difference in the frequency of drinking days between the mindfulness and control group, suggesting that the intervention did not deter participants from consuming alcohol, however, it did reduce the binge pattern of drinking (Mermelstein & Garske, 2015). This study offers important insights as it suggests that the practice of mindfulness may lead to changes in alcohol consumption that are more adaptive.

Together, findings reported in Adams et al. (2013) and Mermelstein and Garske (2015) provide preliminary evidence to suggest that both dispositional mindfulness and mindful practice may protect against the binge pattern of drinking in young people, and promote adaptive drinking behaviours. However, given the preliminary nature of this research, further evidence is needed to replicate these findings. It is possible that the way in which mindfulness protects against binge drinking behaviour may relate to the inverse association with impulsivity, and an enhanced capacity for reflection during decision making. At present, these variables have not specifically been studied together within a sample of binge drinkers. Thus, evaluation of trait-mindfulness together with reflection-impulsivity, rash impulsiveness and reward sensitivity, may provide new insights into how mindfulness is linked to lower rates of alcohol use.

**Summary**

In summary, the aforementioned studies indicate that trait-mindfulness is associated with lower levels of substance use, binge drinking, and impulsivity. At present, only two studies have investigated the role of mindfulness in a binge
drinking context (Adams et al., 2013; Mermelstein & Garske, 2015). Although these studies provide preliminary support for the protective role of mindfulness, further research is warranted to replicate these findings. It is argued that mindful processes, such as focusing attention to the present experience in a nonevaluative way, may modify the relationship between impulsivity and binge drinking, where higher levels of trait mindfulness may weaken the relationship between impulsivity and binge drinking.
CHAPTER FIVE

Aims of the Current Thesis

Rationale

The studies reviewed in this thesis indicate that the deleterious effects of repeated binge episodes place young binge drinkers at increased risk of developing impairment to executive functions, and disorders of addiction or substance misuse (Maurage et al., 2012; Maurage et al., 2009; Obernier et al., 2002). While consistent empirical evidence implicates rash impulsivity and reward sensitivity in the development of hazardous alcohol use and dependence (Gullo et al., 2014; Gullo et al., 2011), there has been far less investigation of these domains in the context of binge drinking. Given the binge pattern of drinking is qualitatively different from other forms of drinking, it is possible that the way in which reward sensitivity and rash impulsiveness influence the binge pattern of drinking may differ to that of hazardous alcohol use.

Emerging evidence indicates that substance users, gamblers, and alcohol addicted cohorts display impairments in reflection-impulsivity, by gathering and evaluating less information, and performing with greater inaccuracy during the decision-making process (Clark et al., 2006; Lawrence et al., 2009; Solowij et al., 2012). While preliminary evidence suggests that binge drinkers may exhibit similar patterns of decision making to those with issues of addiction and substance misuse (Bø et al., 2016; Townshend et al., 2014), inconsistent evidence prevents conclusions to be drawn regarding the decisional patterns of young binge drinkers (Banca et al., 2015). Despite this, it appears that investigation of decisional patterns indicative of reflection-impulsivity may provide important
insights into the cognitive processes that relate to patterns of drinking and substance misuse.

Together, there is strong empirical evidence that implicates impulsivity in the development and maintenance of alcohol misuse (Aragues et al., 2011; Dawe et al., 2004; Gullo et al., 2011). Although extensive research has investigated the role of impulsive domains in alcohol misuse, there has been little integration across impulsive domains to understand how multiple facets of impulsivity interact together, and explain alcohol use behaviour. As such, it was argued in this thesis that integration of impulsivity across personality and cognitive domains, namely, reward sensitivity, rash impulsiveness, and reflection-impulsivity, may provide new insights into how an impulsive profile may influence the binge pattern of drinking. Further, it was argued that reflection-impulsivity may elicit greater influence over binge drinking behaviour compared to reward sensitivity and rash impulsiveness, due to the proximal nature of decisional patterns and behaviour.

In addition, while a series of cognitive factors, such as drinking refusal self-efficacy, and drinking expectations have consistently been shown to interact with impulsivity and explain how an impulsive personality influences alcohol and substance misuse (Gullo et al., 2010a), there is scope for investigation of additional behavioural and cognitive domains to further explain the impulsivity – alcohol misuse relationship.

To build upon this line of research, it was proposed that the investigation of risk taking, and trait-mindfulness, as behavioural and cognitive variables, respectively, may provide novel insights that may be relevant in understanding
the impulsivity - alcohol use relationship. While empirical research suggests that risk taking and trait-mindfulness are associated with impulsivity and alcohol misuse, few studies have specifically examination these variables in the context of the two-factor model.

**Aims of the Present Thesis**

The overall aim of this thesis is to understand how impulsivity, across personality and cognitive domains, may relate to binge drinking in young adults. It has been argued that elevated impulsivity, specifically, rash impulsiveness, reward sensitivity, and reflection-impulsivity, are likely to predict greater binge drinking. The second aim of this thesis is to explore how risk taking and trait-mindfulness relate to impulsivity and influence the binge pattern of drinking. As such, it has been argued that risk taking, and trait-mindfulness, will each interact with impulsivity and predict binge drinking. Therefore, the overall aims of this thesis are:

1. To investigate the personality domains, rash impulsiveness and reward sensitivity, together with the cognitive domain, reflection-impulsivity, in the prediction of binge drinking.

2. To investigate risk taking and trait-mindfulness together with impulsivity, namely, rash impulsiveness, reward sensitivity, and reflection-impulsivity, in the prediction of binge drinking.

To address the study aims, a cross-sectional investigation was carried out in a community sample of 101 young adults. For ease of interpretation, evaluation of the thesis aims was conducted over two studies. The first study presents an investigation of the role of rash impulsiveness, reward sensitivity, and reflection-
impulsivity, in the prediction of binge drinking. In addition, this study will examine reflection-impulsivity as a mediator of the relationship between trait-impulsivity and binge drinking. Hierarchical regression analyses and mediation analyses will be utilised to test the following hypotheses:

1. It is hypothesised that reflection-impulsivity will explain more variance in binge drinking compared to the two-factor model.

2. It is hypothesised that reflection-impulsivity will mediate the relationship between rash impulsivity and binge drinking.

3. In accordance with the two-factor model, it is hypothesised that rash impulsiveness and reward sensitivity will differentially relate to binge drinking.
   a. Specifically, it is hypothesised that the association between rash impulsiveness and alcohol use will be stronger in high-binge drinkers.
   b. Further, it is hypothesised that the association between reward sensitivity and alcohol use will be stronger in low-binge drinkers.

The second study presents an investigation of the role of risk taking and trait-mindfulness in the prediction of binge drinking. The study will investigate risk taking as a mediator of the relationship between impulsivity and binge drinking. Additionally, trait-mindfulness will be investigated as a moderator of the relationship between impulsivity and binge drinking. Hierarchical regression, path analytic, and moderation analyses will be utilised to test the following hypotheses:
1. It is hypothesised that risk taking will significantly and positively predict levels of binge drinking.
   
a. It is hypothesised that risk taking will mediate the relationship between impulsivity (both rash-impulsivity and reward sensitivity) and binge drinking.

2. It is hypothesised that trait-mindfulness will be a significant negative predictor of binge drinking.
   
a. It is hypothesised that trait-mindfulness will moderate the relationship between reflection-impulsivity and binge drinking.

The two studies will be followed by a general discussion which will review and integrate the main research findings and present the clinical and research implications of this thesis. The research limitations will also be discussed with reference to directions for future research, followed by concluding remarks.
CHAPTER SIX

Method

Participants

A power analysis using the GPower computer program (Faul, Erdfelder, Lang, & Buchner, 2007) was calculated to establish the sample size required to test the hypotheses with adequate power. The effect sizes reported in Townshend et al. (2014) indicate a relatively small effect be expected (Cohen, 2013). The analysis indicated that a total sample of 70 participants would be needed to detect a small effect ($\eta^2_p = .11$) with power set at .80 and alpha at .05.

One hundred and one adult participants were recruited, ranging in age from 18 to 35 years (M 26.6, SD 3.2), who completed a battery of self-report and behavioural measures. One case was deleted from the analysis due to a computer malfunction, where online questionnaire data was not saved. All participants met the study inclusion criteria, which required participants to be 18 years or older; there was no exclusion criteria.

The sample comprised 55 females (55%) and 45 males (45%). Thirty-four percent of the sample were employed on a full-time basis, whilst 51% were either part-time or casually employed. Twenty-three percent of participants completed undergraduate studies as their highest level of education, whilst 58% had achieved either honours or postgraduate degree.

On average, participants drank nine standard drinks per week (range 0 to 44, M = 9.0 SD = 8.2) and four alcoholic drinks per sitting (range 0 to 13, M = 4.1, SD = 2.6). Fifty-two percent of participants’ alcohol use was considered low risk (AUDIT score ≤ 7), 40% of the sample drank alcohol at a risky or hazardous
level (AUDIT score 8–15), 6% drank alcohol at a high-risk or harmful level (AUDIT score 16-19), and 1% consumed alcohol at a high-risk level (AUDIT score ≥ 20). On average, participants obtained a mean binge score of 15.6 (SD = 11.2), scores ranged between 1.2 and 46. Drug and tobacco use was relatively low within the sample (see Table 6.2). A majority of drug use within the sample occurred monthly or less. Participant demographic information is presented in Table 6.1.
# Table 6.1

**Participant Demographics**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Males</th>
<th>Females</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Employment Status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full time</td>
<td>21 (46.6%)</td>
<td>13 (23.6%)</td>
<td>34 (34%)</td>
</tr>
<tr>
<td>Part time</td>
<td>10 (22.4%)</td>
<td>7 (12.7%)</td>
<td>17 (17%)</td>
</tr>
<tr>
<td>Casual</td>
<td>11 (24.4%)</td>
<td>25 (45.5%)</td>
<td>36 (36%)</td>
</tr>
<tr>
<td>Unemployed</td>
<td>3 (6.6%)</td>
<td>10 (18.2%)</td>
<td>13 (13%)</td>
</tr>
<tr>
<td><strong>Education Achieved</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High School</td>
<td>7 (15.5%)</td>
<td>6 (10.9%)</td>
<td>13 (13%)</td>
</tr>
<tr>
<td>Undergraduate degree</td>
<td>13 (28.9%)</td>
<td>10 (18.2%)</td>
<td>23 (23%)</td>
</tr>
<tr>
<td>Honours degree</td>
<td>13 (28.9%)</td>
<td>26 (47.3%)</td>
<td>39 (39%)</td>
</tr>
<tr>
<td>Postgraduate degree</td>
<td>8 (17.8%)</td>
<td>12 (21.8%)</td>
<td>20 (20%)</td>
</tr>
<tr>
<td>Other</td>
<td>4 (8.9%)</td>
<td>1 (1.8%)</td>
<td>5 (5%)</td>
</tr>
<tr>
<td><strong>Age of first drink</strong></td>
<td>M = 15.0 (SD = 3.4)</td>
<td>M = 14.30 (SD = 2.8)</td>
<td>M = 14.6 (SD = 3.1)</td>
</tr>
<tr>
<td><strong>Age of regular drinking</strong></td>
<td>M = 16.9 (SD = 4.5)</td>
<td>M = 15.45 (SD = 5.6)</td>
<td>M = 16.1 (SD = 5.2)</td>
</tr>
</tbody>
</table>

*Note: N = 100*
Table 6.2

*Frequency of Drug and Tobacco Use*

<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>≥ Monthly</th>
<th>≤ 4x Month</th>
<th>≤ 3x Week</th>
<th>≥ 4x Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobacco</td>
<td>77%</td>
<td>15%</td>
<td>2%</td>
<td>2%</td>
<td>4%</td>
</tr>
<tr>
<td>Ecstasy</td>
<td>81%</td>
<td>15%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Cannabis</td>
<td>81%</td>
<td>13%</td>
<td>1%</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>Speed</td>
<td>88%</td>
<td>8%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Cocaine</td>
<td>79%</td>
<td>16%</td>
<td>1%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>GHB</td>
<td>93%</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>LSD</td>
<td>90%</td>
<td>5%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Magic</td>
<td>91%</td>
<td>4%</td>
<td>0%</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>Mushrooms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzodiazepines</td>
<td>78%</td>
<td>11%</td>
<td>2%</td>
<td>2%</td>
<td>1%</td>
</tr>
<tr>
<td>Opiates</td>
<td>94%</td>
<td>2%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Inhalants</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

*Note.* N = 100

Measures

**Demographic information**

A set of self-report demographic questions were included to ascertain participant age, gender, employment and education. Participants were also asked to indicate information about drug use history, smoking, the age when they first drank alcohol, and the age when they began to regularly drink alcohol. Appendix A displays the demographic questions presented to participants.
The Automatic-Balloon Analogue Risk Task

The Automatic Balloon Analogue Risk Task (BART-A; Pleskac, Wallsten, Wang, & Lejuez, 2008) is a computer-generated task that provides a behavioural measure of risk taking. This task is a modified version of the original Balloon Analogue Risk Task (Lejuez et al., 2002). Specifically, the BART-A provides a more reliable and accurate measure of risk taking by capturing the desired number of balloon pumps for each trial, regardless of whether the balloon bursts or inflates. In contrast, the original BART does not obtain a measure of desired balloon pumps if the balloon bursts during a trial. The software used to run the BART-A was Inquisit 4 (2015).

In this task, participants are presented with a single balloon on a computer screen and instructed to type in the number of desired pumps to inflate the balloon. Participants are awarded a digital currency of 5 cents for each pump, thus the greater number of pumps awards more money. However, if the balloon bursts before the selected number is reached, no money is issued. Participants are instructed that the balloon may burst at any given point between 1 and 128 pumps, and are unaware of the explosion point for each balloon. If the number entered does not exceed the explosion point for that balloon, the balloon inflates and the money earned is deposited at the right-hand corner of the screen; feedback is given to the participant, where the number of pumps required for the balloon to burst is presented on the screen. There are 30 trials and participants are instructed to win as much money as they can. Prior to the task participants are informed that they are not playing for real money. See Appendix B for written instructions provided to participants completing the BART-A.
Performance on the BART-A is measured by the average number of wanted pumps or ‘target score’ (Pleskac et al., 2008). The BART-A has demonstrated predictive validity of substance use, good external validity, and is associated with real-world risk-taking behaviour (Aklin et al., 2005; Lejuez et al., 2003).

The Domain Specific Risk-Taking Scale

The Domain Specific Risk-Taking Scale (DSRT; Weber et al., 2002) is a 40-item self-report questionnaire that provides a measure of risk taking across five domains: financial decisions, health and safety, recreational, ethical, and social decisions. A 30-item short version was developed to enhance applicability to a wider range of ages, cultures, and educational levels (Blais & Weber, 2006). The 30-item version was used in the current study. For risk taking, participants are instructed to rate the likelihood that they would engage in activities ranging from one (“Extremely Unlikely”) to seven (“Extremely Likely”). Example items include “Admitting that your tastes are different from those of a friend”, and “Walking home alone at night in an unsafe area of town”. The DSRT also provides a measure of risk taking, as well as risk perception, however for the purposes of this study, only the risk-taking scales were used.

The DSRT has demonstrated good internal-consistency for risk taking ($a = .71-.86$) and risk perception ($a = .74-.83$) and exhibits reliability across age groups and cultures. The DSRT questionnaire is presented in Appendix C.

The Information Sampling Task

The Information Sampling Task (IST; CANTAB Cambridge Cognition Ltd.) is a computer-generated task that provides a cognitive measure of decision
making without placing demands on visual processing and working memory (Clark et al., 2006). Participants are presented with a 5 x 5 matrix of grey boxes on a touch screen monitor. Touching a box immediately opens it to reveal one of two colours that correspond with matching panels at the bottom of the screen. Participants decide which colour is in the majority by opening a desired number of boxes. There are two conditions and ten trials per condition. The fixed-win (FW) condition awards the participant 100 points for a correct decision regardless of number of boxes opened, while the Decreasing-win (DW) condition deducts 10 points for each box opened from a maximum of 250 points. Both conditions deduct 100 points for an incorrect decision.

Performance on the IST is measured by the number of boxes opened, total correct points, p-correct (probability of being correct at the point of decision), sampling errors (selection of colour in majority at time of decision, but not in the majority overall), discrimination errors (selection of the colour in the minority at time of decision), and response latency (Clark et al., 2006). The verbal instructions for the IST provided to the participants are presented in Appendix D. The IST has demonstrated validity having repeated use in previous studies of reflection-impulsivity, and is shown to measure reflection-impulsivity as a distinct, well defined dimension of impulsivity (Caswell et al., 2015).

The Sensitivity to Punishment and Sensitivity to Reward Questionnaire Short Form

The Sensitivity to Punishment and Sensitivity to Reward Questionnaire Short Form (SPSRQ-S; Torrubia et al., 2001) is a 48-item self-report questionnaire that provides a measure of the two motivational systems proposed by Gray (1987), the Behavioural Inhibition System (BIS) and the Behavioural
Approach System (BAS). A short version containing 35-item was developed to improve the psychometric properties and factor structure of the tool (O'Connor, Colder, & Hawk, 2004).

In this thesis, the Sensitivity to Reward (SR) subscale was administered as a measure of reward sensitivity. This subscale contains 17 items (e.g., “Do you like to be competitive in all of your activities?”, and “Do you sometimes do things for quick gains”). Items are scored by selecting “Yes” or “No”. Items from the SR subscale are presented in Appendix E. The SR subscale has demonstrated good convergent and discriminant validity and acceptable reliability ($a=.70$) (Cooper & Gomez, 2008).

**The Eysenck Questionnaire**

The Eysenck Questionnaire (I$_7$; Eysenck et al., 1985) is a 54-item dichotomously scored yes/no questionnaire containing three subscales – Impulsiveness (19 items), Venturesomeness (16 items), and Empathy (19 items). In this thesis, the Impulsiveness subscale was administered as a measure of rash impulsiveness. Example items on the I$_7$ include “Do you often buy things on impulse?” and “Do you mostly speak without thinking things out?” (see Appendix F for questionnaire). The I$_7$ impulsiveness subscale has been used widely in non-clinical samples and has demonstrated good reliability ($a=.87$) and construct validity, evidenced by factor analytic techniques demonstrating the I$_7$ loads onto a rash impulsiveness factor together with other self-report measures of impulsivity (Whiteside & Lynam, 2001).
The Alcohol Use Questionnaire

The Alcohol Use Questionnaire (AUQ; Mehrabian & Russell, 1978) is a 12-item self-report measure that provides a quantity-frequency index of alcohol consumption over the past six months based on participant estimates of drinking days, quantity consumed, and drinking pattern. Examples of AUQ items include “On how many days per week do you drink wine, or any type of wine product?” and “When you do drink, how fast do you drink?”. Items are scored by selecting one of a range of options specific to each question (e.g., “2 days per week” or “1 drink in 2 hours”). See Appendix G for AUQ items. The AUQ has demonstrated good reliability of drinking quantity and pattern (Townshend & Duka, 2002), and is considered a valid measure of binge drinking (Bø et al., 2016; Townshend et al., 2014). The AUQ provides a binge score based on the speed of drinking, number of times being drunk in the previous 6 months, and percentage of times getting drunk when drinking (Townshend et al., 2014). The formula used for the AUQ binge score is as follows:

\[(4 \times \text{Item 10}) + \text{Item 11} + (0.2 \times \text{Item 12})\]

The Alcohol Use Disorders Identification Test

The Alcohol Use Disorders Identification Test (AUDIT; Saunders et al., 1993) is a 10-item self-report measure that provides a screen of hazardous and harmful levels of alcohol consumption (e.g., “How often do you have six or more standard drinks on one occasion?” and “How often during the last year have you had a feeling of guilt or remorse after drinking?”). Items are rated on a 5- and 3-point Likert scale that vary between questions (e.g., “Never” to “Daily or almost Daily”; or “No” to “Yes, during the last year”). Appendix H displays items measured by the AUDIT.
The AUDIT demonstrates good internal reliability across inpatient, rural, and urban populations (\(a=.80-.94\)), test-retest reliability (\(r=.88\) over six weeks) (Daeppen, Yersin, Landry, Pécoud, & Decrey, 2000), and is sensitive to non-dependent problem drinkers (Dawe, 2002; Kokotailo et al., 2004).

**The Kentucky Inventory of Mindfulness Skills**

The Kentucky Inventory of Mindfulness Skills (KIMS; Baer et al., 2004) is a self-report measure containing 39 items that assess four mindfulness components: Observing, Describing, Acting With Awareness, and Accepting Without Judgment. The KIMS measures a general tendency to be mindful in daily life, without prior experience of meditation. *Observing* skills involve observing or attending to a variety of stimuli such as bodily sensations, cognitions, emotions, sounds and smells. *Describing* skills involve describing or labelling observed phenomena without judgement or conceptual analysis. *Acting With Awareness* skills involve the ability to engage in an activity with undivided attention, or to focus with awareness on one thing at a time. *Accepting Without Judgement* skills involve being non-judgemental of the present-moment experience, by refraining from applying evaluative labels such as “good” or “bad”, or right or wrong.

Items are rated on a five-point Likert scale ranging from one (“Never or rarely true”) to five (“Very often or always true”); 18 items are reverse scored. Examples of KIMS items include “When I do things, my mind wanders off and I’m easily distracted” and “I tend to do several things at once rather than focussing on one thing at a time”. Items measured by the KIMS are included in Appendix I.
The KIMS has demonstrated good internal consistency in student and clinical samples (Observe, \(a=.91\); Describe, \(a=.84\); Act With Awareness, \(a=.83\); Accept Without Judgement \(a=.87\)) and test-retest reliability (Observe, \(r=.65\); Describe, \(r=.81\); Act With Awareness, \(r=.86\); Accept Without Judgement \(r=.83\)) (Baer et al., 2004; Baum et al., 2010).

**Procedure**

The study was approved by the Deakin University Human Research Ethics Committee, Victoria, Australia. Participants were recruited between January and September of 2015 by local advertisements in university-based settings, and by snowballing techniques, where participants were invited to pass on information about the study to contacts they deemed appropriate (Lovatt, Mason, Brett, & Peters, 2010).

Participants completed the study at the Deakin University Cognitive Neuroscience Laboratory. Participants were provided with a plain language statement, presented in Appendix J, that detailed the study purpose, procedure, confidentiality practices, remuneration, and consent. In the plain language statement, participants were informed that they would receive a $10 Coles/Myer voucher once they had completed all parts of the study. In addition, participants were provided with a verbal overview of information included in the plain language statement, and given the opportunity to discuss the study and to ask questions. Once participants had read the plain language statement, they were asked to sign the consent form, presented in Appendix K.

In this study, participant demographic information, the I7, SPSRQ, KIMS, DSRT, AUQ, and AUDIT were administered together in an online questionnaire.
Demographic questions collected information about participant gender, age, employment, education, age of first drink, age of regular drinking, incidence of drug use, and frequency. The behavioural tasks were administered together, the IST was administered first, followed by the BART-A. The order of tasks was counterbalanced with participants alternating between either completing the self-report online questionnaire first, or the behavioural measures first, in order to prevent order effects confounding the data. When completing the IST, the fixed-win and decreasing-win conditions were also counterbalanced.

Once consent was obtained, each participant was issued with a unique identification code and instructed to input this code prior to starting each task. The identification code could not be linked back to the participants in any way, and were used to combine data from each outcome measure. The primary researcher accompanied each participant throughout their involvement in the study and facilitated access to all tasks.

To complete the online questionnaire, participants were seated in front of a computer and prompted to enter their identification code. Once entered, participant entered their demographic information and completed the I7, SPSRQ, KIMS, DSRT, AUQ, and AUDIT.

To complete the behavioural tasks, participants were seated in front of the CANTAB tablet to complete the IST. Verbal instructions were provided by the primary researcher, see Appendix D for the script. Participants were guided through a practice trial, where they were instructed to touch the grey boxes displayed on the screen in order to decide which colour was in the majority.
Once the practice trial was completed, participants would begin either the fixed- or decreasing-win condition. In the fixed-win condition, participants were informed that they could open as many boxes as they wish in order to decide which colour was in the majority. In the decreasing-win, participants were informed to choose which colour was in the majority, however, they would lose 10 points with each box opened. There were ten trials for each condition, and at the end of each condition the total points earned were displayed on the screen. Participants were then provided verbal instructions for the second condition by the primary researcher.

Following completion of the IST, participants were directed to a computer to complete the BART-A, and prompted to enter their identification code. Written instructions were displayed on the computer screen for participants to read, see Appendix B. The primary researcher sat by the participant to answer any questions. Participants were instructed to inflate a balloon by entering in a desired number of pumps for each trial. Each pump awarded a digital currency of five cents. If the balloon inflated to the specified number of pumps, the money for each pump would be saved in a bank, however, if the balloon burst, the money would be lost. Participants were informed that the balloon would bust at 128 pumps, that the average number of pumps was 64, and that they could earn the most money on average if they pumped 64 times on each trial. The BART-A included thirty trials, after each trial, participants were provided feedback regarding either the number of pumps which the balloon would have exploded on successfully terminated trials, or, of the explosion point where the balloon burst. Once participants completed all trials, the total value of digital money earned was displayed on the screen.
Upon completion of all self-report and behavioural measures, participants were provided with a $10 Coles/Myer voucher and thanked for their contribution. On average, participation in the study took approximately one hour for each participant.
CHAPTER SEVEN

Study One: Examining the Role of Rash Impulsiveness, Reward Sensitivity, and Reflection-Impulsivity in Young Binge Drinkers

Overview

This chapter presents the rationale, methodology, results, and discussion of the first study. The primary aim of this study is to expand on a series of studies that were reviewed in Chapters Two and Three (Banca et al., 2015; Bø et al., 2016; Clark et al., 2006; Gullo et al., 2010a; Gullo et al., 2011; Townshend et al., 2014) by integrating theory of impulsivity across trait and cognitive domains. Specifically, the study aims to examine the two-factor model together with reflection-impulsivity in the prediction of binge drinking. It is argued that evaluation of these impulsive modalities together may enhance the understanding of how an impulsive profile may influence the binge pattern of drinking.

Rationale

The literature defines binge drinking as an episodic pattern of alcohol consumption that is rapid, high in quantity, leads to intoxication, and is followed by a period of abstinence (Hermens et al., 2013). As discussed in Chapter One, empirical evidence has identified that the specific binge pattern is qualitatively different from other forms of drinking, is neurotoxic, and implicated in the development of neural degeneration in the prefrontal regions of the brain (Courtney & Polich, 2009; Hermens et al., 2013). The processes of alcohol intoxication and withdrawal each play a role in neural degeneration through processes of neurotoxicity, inflammation, and kindling-like processes that are associated with deficits in executive functions such as memory, attention,
decision making, inhibitory control, and impulsivity (Crews & Boettiger, 2009; Duka et al., 2003; Obernier et al., 2002; Petit, Maurage, Kornreich, Verbanck, & Campanella, 2014). Empirical evidence indicates that deficits associated with binge drinking accumulate over time, and correspond with the quantity of binged alcohol, and frequency of binge episodes (Maurage et al., 2012; Maurage et al., 2009). Impairment in executive functions place young people at greater risk of developing alcohol dependence due to an inability to inhibit and reflect on automatic responding during the decision-making process (Crews & Boettiger, 2009).

Despite this, not all people who binge drink go on to develop problems of addiction. As such, considerable research has been conducted to identify risk factors that delineate between those who are likely to remain social drinkers, and those who are at risk of developing issues of addiction and substance misuse. Impulsivity is one such risk factor that research consistently links to problems of alcohol misuse and addiction (Aragues et al., 2011). Two domains of impulsivity argued to play a role in the development of addiction are reward sensitivity and rash impulsiveness (Dawe et al., 2004). Reward sensitivity, a heightened propensity toward rewarding stimuli and subsequent motivation to seek rewards in the environment, is argued to drive initial alcohol use (Dawe et al., 2004). Whilst rash impulsiveness, the inability to inhibit or modify approach behaviour, is argued to drive ongoing alcohol use despite negative consequences (Loxton et al., 2008a).

These domains of impulsivity each play a differential role in driving hazardous alcohol use and addiction through distinct neurobiological and cognitive processes. Specifically, reward sensitivity is influenced by functioning
of the mesolimbic system (Beaver et al., 2006) and it is argued to drive initial alcohol use. Those higher in reward sensitivity are likely to try alcohol and drugs at an earlier age (Dissabandara et al., 2014), to have positive expectations of drinking (Gullo et al., 2010a) and to be motivated by social engagement (Egan, Kambouropoulos, & Staiger, 2010). Rash impulsiveness on the other hand is linked to functioning of the orbitofrontal cortex, and is associated with riskier forms of substance use such as polysubstance use, and higher drug dose (Dissabandara et al., 2014; Loxton et al., 2008b). Those with elevations in rash impulsivity are more likely to report perceived impaired control (Kabbani & Kambouropoulos, 2013) and have lower drinking refusal self-efficacy (Gullo et al., 2010a; Harnett et al., 2013). Although these domains each play a unique role in driving alcohol and substance use, it is argued that these processes together, perpetuate alcohol misuse and enhance the risk of addiction (Dawe et al., 2004). As such, reward sensitivity and rash impulsiveness are studied together in the prediction of alcohol and substance use, referred to as the two-factor model (Gullo et al., 2011).

Empirical studies have established the two-factor model consistently predicts alcohol and substance misuse and dependence (Gullo et al., 2010a; Gullo et al., 2010b; Harnett et al., 2013); further, a series of studies have reported associations between reward sensitivity and binge drinking, as well as links between disinhibition and binge drinking (Castellanos-Ryan et al., 2011; Franken & Muris, 2006a). Despite this, the application of the two-factor model specifically to binge drinking has received less attention. Given the binge pattern of drinking is qualitatively different from global alcohol consumption (Hermens et al., 2013), the application of the two-factor model to this style of drinking may provide
important insights into how the impulsivity profile may link to binge drinking behaviour in young people.

Building upon this framework, a series of cognitive mediators, such as drinking refusal self-efficacy, and drinking expectations, have been identified to play a mediating role in the relationship between rash impulsiveness, reward sensitivity, and alcohol misuse (Gullo et al., 2010a; Harnett et al., 2013; Kabbani & Kambouropoulos, 2013). This line of research indicates that although rash impulsiveness and reward sensitivity play an important role within hazardous alcohol misuse, additional factors, particularly those relating to cognition, also carry significant influence on drinking behaviour. Consequently, it is likely that investigation of novel cognitive or behavioural variables within this framework may provide important insights into additional factors that may drive patterns of drinking.

Emerging research identifies reflection-impulsivity, a cognitive domain of impulsivity, as a potential risk factor in the development of substance misuse, dependence, and binge drinking. Reflection-impulsivity is a cognitive subtype of impulsivity that refers to the propensity to gather and evaluate information during the decision-making process, followed by subsequent decisional accuracy (Kagan, 1966). A growing body of research indicates that substance users, ex-substance users, and problem gamblers display impairments in reflection-impulsivity, evidenced by decision-making patterns that are rapid, based on reduced information gathering or evaluation, and subsequent decisional inaccuracy (Clark et al., 2006; Clark et al., 2009; Lawrence et al., 2009).
In addition to substance users and gamblers, recent empirical evidence suggests that reflection-impulsivity may also be implicated in binge drinking. To date, three empirical studies have investigated reflection-impulsivity using the Information Sampling Task (IST) in young binge drinkers, reporting mixed findings. First, Townshend et al. (2014) reported high-binge drinkers display deficits in reflection-impulsivity compared to low-binge drinkers, evidenced by high-binge drinkers gathering less information and making more errors on the IST compared to the low-binge group. In contrast, Banca et al. (2015) report no significant difference in the decision making patterns of high- and low-binge drinkers on the IST. Third, Bø et al. (2016) report that elevations in binge drinking significantly predict impulsive patterns of decision making on the IST, however, only in the context of reward contingency. Together, these three studies provide mixed evidence as to whether young binge drinkers display impulsive patterns of decision making compared to non- or low-level binge drinkers. As such, further evaluation of reflection-impulsivity in binge drinking is needed to contribute to this growing body of research, and ascertain whether reflection-impulsivity is linked to the binge pattern of drinking.

Given the binge pattern of drinking is qualitatively different from global alcohol consumption (Hermens et al., 2013), there is utility in investigating the role of impulsivity within this context. Further, there is general consensus that multiple domains of impulsivity are implicated in alcohol use and binge drinking, however, a shortcoming of this research is that impulsive domains are largely studied in isolation of one another. As such, integration of impulsive frameworks across self-report, behavioural, and cognitive modalities is needed to enhance the
understanding of how elevations in impulsivity may enhance the risk of binge
drinking behaviour in young people.

As such, the current study aims to investigate the two-factor model
together with reflection-impulsivity in a sample of binge drinkers. By integrating
these impulsive domains, this study will explore the collective, and differential
role of each in predicting binge drinking. Consistent with prior research, it is
possible that the differential pathways of reward sensitivity and rash
impulsiveness may account for distinct patterns of binge drinking (Gullo et al.,
2014; Harnett et al., 2013). Namely, it is possible that these domains of
impulsivity may delineate between drinking that is social, motivated by having
fun with friends, and binge drinking that is problematic, such as drinking in
greater volumes, and difficulty ceasing despite potential negative consequences.

Specifically, given rash impulsiveness is associated with heavier and
riskier substance abuse (Dissibandara et al., 2014), and is driven by functioning
of the orbitofrontal cortex, a region particularly vulnerable to the neurotoxic
effects of alcohol (Bechara, 2005; Horn et al., 2003), it is possible that in the
context of binge drinking, rash impulsiveness may be associated with heavier
levels of binge drinking. On the other hand, reward sensitivity is associated with
less harmful forms of drinking, and elevated motivation driven by social factors
such as positive drinking expectancies and social cohesion (Egan et al., 2010;
Gullo et al., 2010a), as such, it is possible that reward sensitivity is associated
with lower levels of binge drinking.

In addition, studies investigating the decisional patterns of young binge
drinkers primarily explore reflection-impulsivity as an outcome variable, and
argue that impulsive patterns of decision making associated with binge drinking may be a product of the deleterious effect of binge drinking that accumulate over time (Bø et al., 2016; Townshend et al., 2014). In contrast, evidence reported in Clark et al. (2006), Clark et al. (2009), and Lawrence et al. (2009) indicate that decision making patterns may be indicative of pre-existing cognitive functioning that is associated with elevated substance misuse or addiction. Given the cross-sectional nature of these studies, conclusions regarding the directionality of these associations cannot be made.

It is possible that impulsive patterns of decision making may reflect a premorbid vulnerability that stems from elevations in trait impulsivity, which together drive greater levels of binge drinking. As such, the present study will explore the predictive utility of reflection-impulsivity in binge drinking, together with domains from the two-factor model. It is further argued that reflection-impulsivity may explain more variance in binge drinking when compared to rash impulsiveness and reward sensitivity. This argument is based upon evidence that cognitive factors appear to play a proximal role in drinking patterns, whilst rash impulsiveness and reward sensitivity appear to play a distal role within this context (Gullo et al., 2010a; Gullo et al., 2014). Namely, while rash impulsiveness and reward sensitivity may influence binge drinking through an enhanced drive toward reward, and a reduced capacity to inhibit behaviour, reflection-impulsivity may explain more variance in binge drinking through a reduced tendency to gather and evaluate information when making decisions about drinking.

Finally, it is argued that the relationship between rash impulsiveness and binge drinking may be mediated by reflection-impulsivity. This argument is made
based upon the theoretical link between rash impulsiveness and reflection-impulsivity. Namely, impulsive decisional patterns, such as the tendency to make snap decisions with little consideration of the information at hand, may be a cognitive marker of rash impulsivity, the tendency to engage in spontaneous behaviour with little consideration of potential consequences (Dawe et al., 2004). As such, it is predicted that the rash impulsive individual is more likely to exhibit impulsive decisional patterns indicative of reflection-impulsivity, which may in turn lead to greater levels of binge drinking.

In summary, it is argued in this study that the investigation of the two-factor model together with reflection-impulsivity may offer new insights into how impulsivity may influence patterns of binge drinking in young people. This research may help to identify personality and cognitive dimensions that underlie both casual and problematic drinking.

**Hypotheses**

1. It is hypothesised that reflection-impulsivity will explain more variance in binge drinking compared to the two-factor model.

2. It is hypothesised that reflection-impulsivity will mediate the relationship between rash impulsivity and binge drinking.

3. In accordance with the two-factor model, it is hypothesised that rash impulsiveness and reward sensitivity will differentially relate to binge drinking.
   a. Specifically, it is hypothesised that the association between rash impulsiveness and alcohol use will be stronger in high-binge drinkers.
b. Further, it is hypothesised that the association between reward sensitivity and alcohol use will be stronger in low-binge drinkers.
Method

Methodology for the current study is presented in Chapter Six. Please refer to this chapter for information regarding the study sample, materials, and procedure. In the present study, the hypotheses were tested based upon data measured by the Information Sampling Task (IST), the Alcohol Use Questionnaire AUQ, the Alcohol Use Disorders Identification Test AUDIT, the Eysenck Questionnaire (I7), and the sensitive to reward subscale from the Sensitive to Reward Sensitive to Punishment Questionnaire (SPSRQ), as well as participant demographic information.

Statistical Analysis

Statistical Package for Social Sciences (SPSS) version 22 was used for preliminary data analysis and hypothesis testing. Pearson’s correlation coefficient was calculated to identify the relationships between reward sensitivity, rash impulsiveness, reflection-impulsivity, binge drinking and alcohol use. Multiple regression was used to test the predictive relationships between impulsive domains and alcohol use. Mediation was conducted using the PROCESS add-on to SPSS, version 2.15 (Hayes, 2013).
Results

Preliminary Data Analysis

Analysis of missing data was conducted, there was one case with all self-report data missing due to a computer malfunction, which was subsequently deleted from the database. No other cases were deleted from the dataset due to missing data. There were 2% missing values across the dataset and less than 5% missing data on any item. Data missing at random was replaced with the series mean (Tabachnick & Fidell, 2013).

Normality of variables was assessed, and data were screened for univariate and multivariate outliers. Univariate outliers were identified as those with a standardised score greater than 3.29 (p<.001) (Tabachnick & Fidell, 2013). Items that exceeded this criterion emerged in the I7 and the IST. These scores were recoded a raw score one unit greater or smaller than the next most extreme score in the distribution which is within 3.29 standard deviations from the mean. This technique allows outlying cases to remain in the dataset, however reduces their impact (Tabachnick & Fidell, 2013). Mahalanobis distance was used to assess multivariate outliers using the criterion p<.001 (Tabachnick & Fidell, 2013). One multivariate outlier emerged with a Mahalanobis distance value exceeding the critical value ($\chi^2 = 69.38$, df = 16), and was consequently deleted. Therefore, the total sample included in the analysis was N = 99.

Variables were screened for normality using Shapiro Wilks statistics. The I7, SPSRQ, and all IST variables were skewed at the p<.001 criterion, while the AUDIT, and AUQ were normally distributed at $p > .001$. However, normality statistics are highly sensitive in large sample sizes and violations in skewness and kurtosis have little impact upon analyses (Tabachnick & Fidell, 2013). Absolute
skewness and kurtosis statistics indicate that there were no severe violations of
distribution (see Table 7.1).

Table 7.1.

Skewness and Kurtosis Indices for Outcome Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Skew (SE = .24)</th>
<th>Kurtosis (SE = .48)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I7</td>
<td>.45</td>
<td>-.65</td>
</tr>
<tr>
<td>SPSRQ</td>
<td>.35</td>
<td>-.66</td>
</tr>
<tr>
<td>AUDIT</td>
<td>.36</td>
<td>-.40</td>
</tr>
<tr>
<td>AUQ</td>
<td>.86</td>
<td>.14</td>
</tr>
<tr>
<td>IST FW Boxes Opened</td>
<td>-.25</td>
<td>-1.12</td>
</tr>
<tr>
<td>P-Correct</td>
<td>-.34</td>
<td>-.75</td>
</tr>
<tr>
<td>Total Correct</td>
<td>-1.11</td>
<td>1.34</td>
</tr>
<tr>
<td>Sampling Error</td>
<td>1.67</td>
<td>3.44</td>
</tr>
<tr>
<td>Discrimination Error</td>
<td>1.70</td>
<td>3.52</td>
</tr>
<tr>
<td>Latency</td>
<td>1.02</td>
<td>.74</td>
</tr>
<tr>
<td>IST DW Boxes Opened</td>
<td>.86</td>
<td>.31</td>
</tr>
<tr>
<td>P-Correct</td>
<td>.70</td>
<td>.80</td>
</tr>
<tr>
<td>Total Correct</td>
<td>-.24</td>
<td>-.83</td>
</tr>
<tr>
<td>Sampling Error</td>
<td>.50</td>
<td>-.54</td>
</tr>
<tr>
<td>Discrimination Error</td>
<td>1.65</td>
<td>2.75</td>
</tr>
<tr>
<td>Latency</td>
<td>.57</td>
<td>.18</td>
</tr>
</tbody>
</table>

Note. N=99
Summary Statistics

Means, standard deviations, and internal consistency data for the self-report variables are presented in Table 7.2. As shown, all measures have acceptable to very high internal consistency. Summary statistics for the behavioural measures, including means, standard deviations, and range data, are presented in Table 7.3. Reliability coefficients for the AUQ are not included in Table 7.2, as the AUQ binge score is a composite score utilising data from three items that measure drinking speed, frequency of binge episodes, and proportion of binging when drinking. The AUQ binge score is considered a valid measure of binge drinking, it has been shown to correlate with diary records of drinking over the past month (Townshend & Duka, 2002). In the present study, the AUQ binge score significantly correlated with the AUDIT total ($r = .58$, $p < .001$), AUDIT consumption ($r = .61$, $p < .001$), AUDIT dependence ($r = .42$, $p < .001$), and AUDIT alcohol-related problems ($r = .36$, $p < .001$). The significant correlations with multiple measures of alcohol use, particularly with the AUDIT consumption indicate that the AUQ Binge score is a valid measure of binge drinking.
Table 7.2.

Descriptive Statistics and Reliability Coefficients for Self-Report Questionnaires

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum Score</th>
<th>Maximum Score</th>
<th>Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>I7</td>
<td>4.83</td>
<td>3.45</td>
<td>0</td>
<td>17</td>
<td>.75</td>
</tr>
<tr>
<td>SPSRQ</td>
<td>7.14</td>
<td>3.68</td>
<td>0</td>
<td>16</td>
<td>.78</td>
</tr>
<tr>
<td>AUDIT</td>
<td>7.70</td>
<td>4.50</td>
<td>0</td>
<td>20</td>
<td>.77</td>
</tr>
</tbody>
</table>

Note. N = 99; SD = Standard Deviation; I7 = Rash Impulsiveness; SPSRQ = Reward Sensitivity; AUDIT = Alcohol Use Disorders Identification Test Total Score; AUQ Binge = Alcohol Use Questionnaire Binge Score
Table 7.3.

Descriptive Statistics for Behavioural Measures

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum Score</th>
<th>Maximum Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>IST Fixed Win</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boxes Opened</td>
<td>16.83</td>
<td>5.73</td>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>P Correct</td>
<td>.85</td>
<td>.10</td>
<td>.64</td>
<td>1</td>
</tr>
<tr>
<td>Total Correct</td>
<td>8.90</td>
<td>1.07</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Sampling Errors</td>
<td>.72</td>
<td>.99</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Discrimination Errors</td>
<td>.54</td>
<td>.72</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Latency</td>
<td>895.43</td>
<td>448.47</td>
<td>222.62</td>
<td>2218.47</td>
</tr>
<tr>
<td>IST Decreasing Win</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boxes Opened</td>
<td>10.13</td>
<td>4.43</td>
<td>3</td>
<td>23</td>
</tr>
<tr>
<td>P Correct</td>
<td>.74</td>
<td>.09</td>
<td>.60</td>
<td>1</td>
</tr>
<tr>
<td>Total Correct</td>
<td>7.83</td>
<td>1.47</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Sampling Errors</td>
<td>1.88</td>
<td>1.40</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Discrimination Errors</td>
<td>.51</td>
<td>.76</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Latency</td>
<td>1405.50</td>
<td>591.03</td>
<td>396.01</td>
<td>3051.50</td>
</tr>
</tbody>
</table>

Note. N = 99; SD = Standard Deviation; AUDIT = Hazardous Alcohol Use; AUQ = Binge Drinking; IST = Information Sampling Task; FW = Fixed Win Condition; DW = Decreasing Win Condition

Interrelationships

Bivariate correlational analysis was conducted to investigate the relationships among variables. Due to the preliminary nature of this study, the criterion p <.05 will be used for significance. However, given the large number of
correlations presented in Table 7.4, the risk of Type I error is inflated and as such, results should be interpreted with caution. As illustrated in Table 7.4, several significant relationships emerged. Statistically significant correlations were found between rash impulsiveness and the IST fixed-win variable boxes opened \((r = -0.21, p < .05)\), and IST decreasing-win variables boxes opened \((r = -0.21, p < .05)\), total correct \((r = -0.25, p < .05)\), and sampling errors \((r = 0.29, p < .01)\). Reward sensitivity was significantly correlated with the IST fixed-win variable sampling error \((r = 0.24, p < .05)\), and IST decreasing-win variables boxes opened \((r = -0.24, p < .05)\), p-correct \((r = -0.20, p < .05)\), total correct \((r = -0.29, p < .01)\), and sampling error \((r = 0.35, p < .01)\). One significant association emerged between discrimination errors in the fixed-win condition and binge drinking \((r = 0.23, p < .05)\). There were no significant correlations between rash impulsiveness or reward sensitivity with alcohol use.
### Table 7.4.

Correlations Between Binge Drinking, Alcohol Use, and Reflection-Impulsivity in the Fixed- and Decreasing-Win Condition

<table>
<thead>
<tr>
<th>Variable</th>
<th>Boxes Opened</th>
<th>P Correct</th>
<th>Total Correct</th>
<th>Samp Error</th>
<th>Discrim Error</th>
<th>Latency</th>
<th>I⁷</th>
<th>SPSRQ</th>
<th>AUQ</th>
<th>AUDIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boxes Opened</td>
<td></td>
<td>.946**</td>
<td>.795**</td>
<td>-.776**</td>
<td>-.105</td>
<td>-.461**</td>
<td>-.206*</td>
<td>-.238*</td>
<td>-.061</td>
<td>.148</td>
</tr>
<tr>
<td>P Correct</td>
<td>.891**</td>
<td></td>
<td>.775**</td>
<td>-.713**</td>
<td>-.282**</td>
<td>-.435**</td>
<td>-.153</td>
<td>-.199*</td>
<td>-.090</td>
<td>.129</td>
</tr>
<tr>
<td>Total Correct</td>
<td>.699**</td>
<td>.806**</td>
<td></td>
<td>-.941**</td>
<td>-.077</td>
<td>-.399**</td>
<td>-.254*</td>
<td>-.289**</td>
<td>-.129</td>
<td>.116</td>
</tr>
<tr>
<td>Samp Error</td>
<td>-.789**</td>
<td>-.720**</td>
<td>-.844**</td>
<td></td>
<td>-.191</td>
<td>.378**</td>
<td>.290**</td>
<td>.349**</td>
<td>.133</td>
<td>-.123</td>
</tr>
<tr>
<td>Discrim Error</td>
<td>-.087</td>
<td>-.425**</td>
<td>-.400**</td>
<td>-.051</td>
<td></td>
<td>.034</td>
<td>-.113</td>
<td>-.132</td>
<td>.030</td>
<td>-.026</td>
</tr>
<tr>
<td>Latency</td>
<td>-.722**</td>
<td>-.623**</td>
<td>-.438**</td>
<td>.540**</td>
<td>.029</td>
<td></td>
<td>-.066</td>
<td>.156</td>
<td>.007</td>
<td>-.047</td>
</tr>
<tr>
<td>I⁷</td>
<td>-.209*</td>
<td>-.194</td>
<td>-.163</td>
<td>.179</td>
<td>-.030</td>
<td>-.003</td>
<td>.471**</td>
<td>.156</td>
<td>.146</td>
<td></td>
</tr>
<tr>
<td>SPSRQ</td>
<td>-.154</td>
<td>-.120</td>
<td>-.177</td>
<td>.235*</td>
<td>-.083</td>
<td>.051</td>
<td>.471**</td>
<td>.189</td>
<td>.091</td>
<td></td>
</tr>
<tr>
<td>AUQ</td>
<td>.060</td>
<td>-.057</td>
<td>-.060</td>
<td>-.112</td>
<td>.228*</td>
<td>-.156</td>
<td>.156</td>
<td>.189</td>
<td></td>
<td>.584**</td>
</tr>
<tr>
<td>AUDIT</td>
<td>.111</td>
<td>.019</td>
<td>.022</td>
<td>-.115</td>
<td>.114</td>
<td>-.118</td>
<td>.146</td>
<td>.091</td>
<td></td>
<td>.584**</td>
</tr>
</tbody>
</table>

Note. N = 99; Samp Error = Sampling Error; Discrim. Error = Discrimination Error; I⁷ = Rash Impulsiveness; SPSRQ = Reward Sensitivity; AUQ = Binge Drinking; AUDIT = Hazardous Alcohol Use; *p < .05, **p < .01; Correlations displayed above the grey line include reflection-impulsivity decreasing-win variables, and those below the line are reflection-impulsivity fixed-win condition variables.
Hierarchical Regression

To test the hypothesis that reflection-impulsivity will explain more variance in binge drinking, compared to the two-factor model, a two-stage hierarchical linear regression was conducted using SPSS version 22. The outcome variable was binge drinking, using the AUQ binge drinking score. Independent variables were entered into the model in two steps. At step one, reward sensitivity and rash impulsiveness were entered into the model to test the relationship between the two-factor model and binge drinking. At step two, the variables boxes opened, and discrimination errors were entered into the model to investigate the additional predictive variance in binge drinking accounted for by reflection-impulsivity. Table 7.5 displays the unstandardized regression coefficients, and the standardised regression coefficients.
Table 7.5.

Hierarchical Regression of the two-factor model and reflection-impulsivity on binge drinking

<table>
<thead>
<tr>
<th>Variables</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>95% CI Lower</th>
<th>95% CI Upper</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1 (R^2 = .04)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rash Impulsiveness</td>
<td>.281</td>
<td>.388</td>
<td>.083</td>
<td>-.498</td>
<td>1.050</td>
<td>.471</td>
</tr>
<tr>
<td>Reward Sensitivity</td>
<td>.477</td>
<td>.349</td>
<td>.156</td>
<td>-.215</td>
<td>1.169</td>
<td>.174</td>
</tr>
<tr>
<td><strong>Step 2 (R^2 = .12, \Delta R^2 = .08)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rash Impulsiveness</td>
<td>.345</td>
<td>.380</td>
<td>.102</td>
<td>-.410</td>
<td>1.100</td>
<td>.367</td>
</tr>
<tr>
<td>Reward Sensitivity</td>
<td>.577</td>
<td>.340</td>
<td>.189</td>
<td>-.098</td>
<td>1.253</td>
<td>.093</td>
</tr>
<tr>
<td>Boxes Opened</td>
<td>.254</td>
<td>.200</td>
<td>.128</td>
<td>-.143</td>
<td>.652</td>
<td>.207</td>
</tr>
<tr>
<td>Discrimination Error</td>
<td>4.036</td>
<td>1.537</td>
<td>.253</td>
<td>.982</td>
<td>7.089</td>
<td>.010</td>
</tr>
</tbody>
</table>

*Note. N = 99; B = Unstandardised Coefficient; SE B = Standard Error of B; \(\beta\) = Standardised Coefficient; CI = Confidence Interval; P = Probability*

At step one, both rash impulsiveness and reward sensitivity accounted for 4% of the variance in binge drinking. The contribution of rash impulsiveness and reward sensitivity was not statistically significant \(F (2, 94) = 2.14, p = 123\). Neither rash impulsiveness nor reward sensitivity uniquely predicted hazardous alcohol use \(t (92) = .724, p = .471\), and \(t (92) = .1.37, p = .174\), respectively). The addition of reflection-impulsivity variables at step two explained a further 8% of the variance in binge drinking, and produced a statistically significant increase in the variance explained \(F (4, 92) = 3.14, p <.05\). Discrimination error was a significant predictor of binge drinking \(t (92) = 2.53, p <.05\), where greater inaccuracy on the IST predicted higher levels of binge drinking. Boxes opened
was not a significant predictor of binge drinking ($t (92) = .1.27, p = 207$). This pattern of results supports the first hypothesis, where greater inaccuracy of performance, indicative of reflection-impulsivity, accounted for significantly more variance in binge drinking compared to that of the two-factor model.

Given the two-factor model did not significantly predict binge drinking, a follow-up hierarchical regression was conducted substituting the outcome variable from AUQ binge score, with the AUDIT total score. This decision was made based upon empirical evidence that reports the two-factor model significantly predicts variance in hazardous drinking, as measured by the AUDIT (Gullo et al., 2010a; Gullo et al., 2011; Kabbani & Kambouropoulos, 2013). Table 7.6 displays the unstandardized regression coefficients, and the standardised regression coefficients.
### Table 7.6.

**Hierarchical Regression of the two-factor model and reflection-impulsivity on hazardous alcohol use**

<table>
<thead>
<tr>
<th>Variables</th>
<th>β</th>
<th>SE B</th>
<th>B</th>
<th>95% CI Lower</th>
<th>95% CI Upper</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1 ((R^2 = .02))</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rash Impulsiveness</td>
<td>.183</td>
<td>.157</td>
<td>.135</td>
<td>-.129</td>
<td>.496</td>
<td>.247</td>
</tr>
<tr>
<td>Reward Sensitivity</td>
<td>.029</td>
<td>.142</td>
<td>.024</td>
<td>-.252</td>
<td>.310</td>
<td>.837</td>
</tr>
<tr>
<td><strong>Step 2 ((R^2 = .03, \Delta R^2 = .04))</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rash Impulsiveness</td>
<td>.220</td>
<td>.158</td>
<td>.162</td>
<td>-.093</td>
<td>.533</td>
<td>.166</td>
</tr>
<tr>
<td>Reward sensitivity</td>
<td>.061</td>
<td>.141</td>
<td>.050</td>
<td>-.219</td>
<td>.341</td>
<td>.668</td>
</tr>
<tr>
<td>Boxes Opened</td>
<td>.135</td>
<td>.083</td>
<td>.169</td>
<td>-.030</td>
<td>.300</td>
<td>.108</td>
</tr>
<tr>
<td>Discrimination Error</td>
<td>.831</td>
<td>.637</td>
<td>.132</td>
<td>-.435</td>
<td>-.435</td>
<td>.196</td>
</tr>
</tbody>
</table>

*Note. B = Unstandardised Coefficient; SE B = Standard Error of B; β = Standardised Coefficient; CI = Confidence Interval; P = Probability*

At step one, both rash impulsiveness and reward sensitivity accounted for 2% of the variance in hazardous alcohol use. The contribution of rash impulsiveness and reward sensitivity was not statistically significant \((F(2, 94) = 1.04, p = 356)\). Neither rash impulsiveness nor reward sensitivity significantly predicted hazardous alcohol use \((t(92) = .1.16, p = .247)\) and \((t(92) = .206, p = .837)\), respectively. The addition of reflection-impulsivity variables at step two explained a further 4% of the variance in hazardous alcohol use, however, the inclusion of reflection-impulsivity variables did not significantly improve the prediction of hazardous drinking \((F(4, 92) = 1.53, p = .197)\). Boxes opened and
discrimination errors were not significant predictors of hazardous alcohol use ($t(92) = 1.63, p = .108$); and ($t(92) = .132, p = .196$), respectively. Contrary to expectations, this pattern of results suggests that neither the two-factor model, nor reflection-impulsivity significantly predicted alcohol use.

**Mediation**

To test the hypothesis that reflection-impulsivity would mediate the relationship between rash impulsiveness and binge drinking, a mediation analysis was conducted using PROCESS add-on to SPSS (Hayes, 2013). Although significant correlations between variables is considered a precondition of mediation, mediation analysis was performed in the present study based upon the recommendation of Hayes (2013). Specifically, it is argued by Hayes (2013) that correlations between variables of interest are not a necessary precondition of mediation, as correlation does not prove, nor disprove, causation. Further, Hayes (2013) argues that study limitations, such as cross-sectional research designs, limit the ability to make causal claims among variables. Thus, Hayes (2013) argues that mediation analysis can be conducted despite a lack of correlation between variables of interest.
Figure 7.1.

Model depicting the direct and mediated effects of reflection-impulsivity on binge drinking

Note. * = significant at p < .05

Figure 7.1 displays the hypothesised mediation model; corresponding unstandardized regression weights are displayed in Table 7.7. The hypothesised model explained 4% of the variance in binge drinking. Specifically, rash impulsiveness had a statistically significant direct effect on reflection-impulsivity boxes opened \( (a = -.355, p < .05) \), where greater rash impulsiveness predicted reduced information sampling on the IST. However, there was no evidence that reflection-impulsivity influenced binge drinking score \( (b = .188, p = .30) \), nor did rash impulsiveness binge drinking \( (c = 530, p = .201) \). A bias-corrected bootstrap confidence interval for the indirect effect \( (ab = -.067) \) based on 1000 bootstrap samples was not significant \( (-.295 \text{ to } .045) \). Taken together, these results do not provide support for the second hypothesis. Specifically, rash impulsiveness did not indirectly influence binge drinking through reflection-impulsivity.
Table 7.7.
Regression Weights for the Mediation Model

<table>
<thead>
<tr>
<th>Path</th>
<th>B</th>
<th>SEB</th>
<th>p</th>
<th>95% CI Lower</th>
<th>95% CI Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R² = .04, F (2, 95) = 4.92, p = .028</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Path a</td>
<td>-.355</td>
<td>.160</td>
<td>.028</td>
<td>-.673</td>
<td>-.037</td>
</tr>
<tr>
<td>Path b</td>
<td>.188</td>
<td>.197</td>
<td>.340</td>
<td>-.202</td>
<td>.579</td>
</tr>
<tr>
<td>Path c’</td>
<td>.597</td>
<td>.421</td>
<td>.159</td>
<td>-.238</td>
<td>1.433</td>
</tr>
<tr>
<td>Path c</td>
<td>.530</td>
<td>.412</td>
<td>.201</td>
<td>-.287</td>
<td>1.348</td>
</tr>
</tbody>
</table>

Note. Confidence intervals and standard errors based on 1000 bootstrap samples.

Exploring the Two-Factor Model and Binge Drinking

The third hypothesis predicted that the association between rash impulsiveness and alcohol use would be stronger in high-binge drinkers, and that the association between reward sensitivity and alcohol use would be stronger in low-binge drinkers. This hypothesis was evaluated using multiple regression on the data that was split into high- and low-binge groups. The sample was grouped into “high-binge” and “low-binge” drinkers by deriving the binge drinking score from the AUQ, and placing those whose score fell above the median (13) in the high-binge group, and those who fell below the median in the low-binge group. When split into groups, there were 51 participants in the low-binge group and 48 in the high-binge group. Table 7.8 displays demographic information for low- and high-binge drinkers.
Table 7.8.

*Participant characteristics for Low-and High-Binge Groups*

<table>
<thead>
<tr>
<th></th>
<th>Low-Binge Mean</th>
<th>SD</th>
<th>High-Binge Mean</th>
<th>SD</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males/Females (freq)</td>
<td>19/33</td>
<td></td>
<td>25/22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>26.1</td>
<td>2.90</td>
<td>27.2</td>
<td>3.0</td>
<td>.088</td>
</tr>
<tr>
<td>Alcohol units per week</td>
<td>6.55</td>
<td>6.33</td>
<td>11.7</td>
<td>9.12</td>
<td>.001</td>
</tr>
<tr>
<td>Alcohol units per sitting</td>
<td>2.76</td>
<td>1.86</td>
<td>5.54</td>
<td>2.83</td>
<td>.000</td>
</tr>
<tr>
<td>Age of first drink</td>
<td>14.6</td>
<td>1.8</td>
<td>14.2</td>
<td>2.2</td>
<td>.367</td>
</tr>
<tr>
<td>Age of regular drinking</td>
<td>17.4</td>
<td>1.3</td>
<td>17.3</td>
<td>1.8</td>
<td>.926</td>
</tr>
<tr>
<td>Binge Score</td>
<td>6.95</td>
<td>3.67</td>
<td>25.12</td>
<td>11.30</td>
<td>.000</td>
</tr>
<tr>
<td>AUDIT Total</td>
<td>5.61</td>
<td>3.71</td>
<td>10.04</td>
<td>4.23</td>
<td>.000</td>
</tr>
<tr>
<td>Reward Sensitivity</td>
<td>6.94</td>
<td>3.62</td>
<td>7.24</td>
<td>3.81</td>
<td>.694</td>
</tr>
<tr>
<td>Rash Impulsiveness</td>
<td>4.54</td>
<td>3.31</td>
<td>4.98</td>
<td>3.36</td>
<td>.528</td>
</tr>
</tbody>
</table>

*Note.* \( N = 99 \); (freq) = Frequency

Bivariate correlational analyses were conducted to investigate the relationships among impulsivity and alcohol use variables after splitting the data into low- and high-binge groups. For ease of interpretation, bivariate correlation tables have been split into separate tables for the fixed-win and decreasing-win conditions. As illustrated in Table 7.9 and 7.10, several significant relationships were observed. Specifically, in the low-binge group, rash impulsiveness and reward sensitivity significantly correlated with sampling error in the fixed-win condition \((r = .30, p < .05, \text{ and } r = .28, p < .05, \text{ respectively})\).
For high-binge drinkers, significant correlations emerged between binge drinking and total correct ($r = -.35$, $p < .05$), and discrimination error in the fixed-win condition ($r = .29$, $p < .05$). In the decreasing win condition, binge drinking significantly correlated with boxes opened ($r = -.35$, $p < .05$), $p$ correct ($r = -.41$, $p < .01$), total correct ($r = -.31$, $p < .05$), and sampling error ($r = .29$, $p < .05$).

Further, reward sensitivity significantly correlated with IST performance in the decreasing-win condition, in particular, with boxes opened ($r = -.45$, $p < .01$), and sampling error ($r = .51$, $p < .01$). Finally, a significant positive correlation emerged between binge drinking and reward sensitivity in high-binge drinkers ($r = .45$, $p < .01$).
Table 7.9.
Correlations Between the Two-Factor Model, Reflection-Impulsivity (Fixed-Win Condition) and Alcohol Use for High- and Low-Binge Drinkers

<table>
<thead>
<tr>
<th>Variable</th>
<th>Boxes Opened</th>
<th>P Correct</th>
<th>Total Correct</th>
<th>Samp Error</th>
<th>Discrim Error</th>
<th>Latency</th>
<th>I^7</th>
<th>SPSRQ</th>
<th>AUQ</th>
<th>AUDIT</th>
<th>AUDIT-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boxes Opened</td>
<td></td>
<td>.872**</td>
<td>.634**</td>
<td>-.814**</td>
<td>-.208</td>
<td>-.713**</td>
<td>-.221</td>
<td>-.184</td>
<td>-.213</td>
<td>-.053</td>
<td>.112</td>
</tr>
<tr>
<td>P Correct</td>
<td>.919**</td>
<td></td>
<td>.846**</td>
<td>-.711**</td>
<td>-.601**</td>
<td>-.585**</td>
<td>-.202</td>
<td>-.060</td>
<td>-.276</td>
<td>-.132</td>
<td>-.046</td>
</tr>
<tr>
<td>Total Correct</td>
<td>.691**</td>
<td>.783**</td>
<td></td>
<td>-.704**</td>
<td>-.704**</td>
<td>-.442**</td>
<td>-.055</td>
<td>-.073</td>
<td>-.347</td>
<td>-.042</td>
<td>-.063</td>
</tr>
<tr>
<td>Samp Error</td>
<td>-.788**</td>
<td>-.774**</td>
<td>-.928**</td>
<td></td>
<td>.086</td>
<td>.610**</td>
<td>.032</td>
<td>.209</td>
<td>.235</td>
<td>-.004</td>
<td>-.045</td>
</tr>
<tr>
<td>Discrim Error</td>
<td>-.010</td>
<td>-.237</td>
<td>-.156</td>
<td>-.104</td>
<td>.074</td>
<td>.110</td>
<td>-.101</td>
<td>.292</td>
<td>.225</td>
<td>.240</td>
<td></td>
</tr>
<tr>
<td>Latency</td>
<td>-.710**</td>
<td>-.662**</td>
<td>-.424**</td>
<td>.485**</td>
<td>.047</td>
<td>.046</td>
<td>.061</td>
<td>.045</td>
<td>-.038</td>
<td>-.178</td>
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<td>-.268</td>
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Note. Samp Error = Sampling Error; Discrim. Error = Discrimination Error; I^7 = Rash Impulsiveness; SPSRQ = Reward Sensitivity; AUQ = Binge Drinking; AUDIT = Hazardous Alcohol Use; *p<.05, **p<.01. Correlations displayed above the grey line are those for high-binge drinkers (N = 47), and those below the line are for low-binge drinkers (N = 52)
<table>
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<tr>
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<th>Total Correct</th>
<th>Samp Error</th>
<th>Discrim Error</th>
<th>Latency</th>
<th>I7</th>
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<td>-.452**</td>
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<td>.304*</td>
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Note. Samp Error = Sampling Error; Discrim Error = Discrimination Error; I7 = Rash Impulsiveness; SPSRQ = Reward Sensitivity; AUQ = Binge Drinking; AUDIT = Hazardous Alcohol Use; *p<.05, **p<.01. Correlations displayed above the grey line are those for high-risk alcohol users (N = 47), and those below the line are for low-risk alcohol user (N = 52).
Multiple Regression

A standard multiple regression was performed between AUDIT Consumption score as the dependent variable, and rash impulsiveness and reward sensitivity as independent variables. The AUDIT-C was chosen as the dependent variable in this analysis given AUQ Binge score was used to split the data. In addition, the AUDIT-C is both conceptually and statistically related to the AUQ Binge ($r = .61, p < .001$), comprising items measuring binge episodes, quantity of drinks per drinking occasion, and drinking frequency. Table 7.11 displays the unstandardized and standardised regression coefficients.

**Table 7.11.**

*Multiple Regression Coefficients for Two-Factor Model Predicting Alcohol Consumption*

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>95% CI</th>
<th>P</th>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower</td>
<td>Upper</td>
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<tr>
<td><strong>Low-Binge ($R^2 = .02$)</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Rash Impulsiveness</td>
<td>-.085</td>
<td>.110</td>
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<td></td>
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<td>Rash Impulsiveness</td>
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<td>.106</td>
<td>.127</td>
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<tr>
<td>Reward Sensitivity</td>
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<td>.094</td>
<td>-.093</td>
<td>-.240</td>
<td>.137</td>
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</table>

*Note.* B = Unstandardised Coefficient; SE B = Standard Error of B; β = Standardised Coefficient; CI = Confidence Interval; P = Probability
In the low-binge group, both rash impulsiveness and reward sensitivity accounted for 2% of the variance in alcohol consumption. This contribution was not statistically significant \((F(2, 48) = .410, p = 0.67)\). Neither rash impulsiveness nor reward sensitivity uniquely predicted alcohol consumption \((t(48) = -.773, p = .44)\), and \((t(48) = -.036, p = .97)\), respectively. This pattern of results was replicated in the high-binge group. Specifically, both rash impulsiveness and reward sensitivity accounted for 1% of the variance in alcohol consumption among high-binge drinkers’ \((F(2, 43) = .306, p = 0.74)\). As such, the unique contribution of rash impulsiveness toward alcohol consumption was not significant \((t(43) = -.746, p = .46)\), nor was reward sensitivity \((t(43) = -.547, p = .59)\). Together, this pattern of results does not provide support for the hypothesis that the association between rash impulsiveness and alcohol use would be stronger in high-binge drinkers, and that the association between reward sensitivity and alcohol use would be stronger in low-binge drinkers.
Discussion

The primary aims of the present study were to investigate the applicability of integrating the two-factor model together with reflection-impulsivity to explore the collective, and differential role of impulsive domains in the prediction of binge drinking. The pattern of results provide support for the first hypothesis. Specifically, reflection-impulsivity significantly enhanced the predictive variance in binge drinking compared to that explained by the two-factor model. Interestingly, neither reflection-impulsivity, nor rash impulsiveness or reward sensitivity, significantly predicted hazardous alcohol use, as measured by the AUDIT.

The second hypothesis in this study was not supported; reflection-impulsivity did not significantly mediate the relationship between rash impulsiveness and binge drinking. Finally, neither rash impulsiveness nor reward sensitivity were significantly related to binge drinking in the overall sample. Thus, the hypotheses that the relationship between rash impulsiveness and alcohol use would be stronger in high-binge drinkers, and that the association between reward sensitivity and alcohol use would be stronger in low-binge drinkers were rejected. Importantly, differential associations did emerge between the two-factor model, reflection-impulsivity, and binge drinking, in higher-level binge drinkers.

Integrating the Two-Factor Model with Reflection-Impulsivity

This is the first study to integrate the two-factor model together with reflection-impulsivity in the prediction of binge drinking. This investigation was driven by an attempt to bridge a series of studies that have investigated these models in hazardous alcohol use and binge drinking (Banca et al., 2015; Bø et al.,
2016; Gullo et al., 2010a; Gullo et al., 2011; Harnett et al., 2013; Townshend et al., 2014). In this study, reflection-impulsivity predicted significantly more variance in binge drinking compared to the two-factor model, providing support for the first hypothesis. Specifically, the variable discrimination errors in the fixed-win condition significantly predicted binge drinking, namely, those who made more discrimination errors on the IST reported greater levels of binge drinking. Discrimination errors are proposed to result from inattention or carelessness, as the error represents the selection of box colour in the minority at the time of decision (Clark et al., 2006). This indicates that those who made more errors due to inattention or carelessness were more likely to binge drink.

This finding builds upon that of Townshend et al. (2014), Banca et al. (2015) and Bø et al. (2016), by indicating that there is utility in exploring patterns of reflection in the prediction of binge drinking. Although the present study, Townshend et al. (2014), and Bø et al. (2016), each report links between lower levels of reflection and binge drinking, it is important to note that there is variation between these studies regarding the IST variable that elicited a significant result. Specifically, Townshend et al. (2014) reports high-binge drinkers sampled less information and made more errors in the fixed-win condition, Bø et al. (2016) reports p-correct, namely, the probability of making a correct choice at the point of decision in the decreasing-win, was significantly predicted by binge drinking, and finally, the present study reports discrimination errors in the fixed-win condition significantly predicted binge drinking. Variation among these variables indicates that although binge drinkers overall appear to make decisions that are more impulsive, there may be variability regarding the way in which young binge drinkers make decisions. Chapter Nine will provide a
comprehensive discussion of the IST variables and task conditions, and how these may relate to the decisional patterns of young binge drinkers.

Inconsistent with study predictions, reflection-impulsivity did not mediate the relationship between rash impulsivity and binge drinking. This was the first study to explore decisional patterns that may relate to the rash impulsive and reward sensitive domains of the two-factor model. Given neurobiological research indicates functioning of the prefrontal neural regions are implicated in rash impulsiveness and impulsive patterns of decision making (Horn et al., 2003; Yokoyama et al., 2015), the present finding was unexpected. However, a significant relationship did emerge between rash impulsiveness and reflection-impulsivity. Specifically, elevations in rash impulsiveness were related to the sampling of less information across both task conditions, and greater performance inaccuracy in the decreasing-win condition. This suggests that individuals who engage in rash behaviour without considering potential negative consequences may make decisions that are based on less information, resulting in subsequent errors. This is the first study to report lower levels of reflection among the rash impulsive individual. Further research may wish to examine this association, particularly among hazardous substance misuses given this population typically display elevated levels of rash impulsiveness (Gullo et al., 2011).

Building upon this finding, the pattern of results reported in this study indicate that the way in which reward sensitivity and rash impulsiveness relate to reflection-impulsivity differs across task condition. Specifically, rash impulsiveness and reward sensitivity were more consistently related to reflection-impulsivity in the decreasing-win condition of the IST, compared to the fixed-win condition. Further, reward sensitivity was more strongly related to impulsive
patterns of decision making in the decreasing-win condition of the IST, compared to rash impulsiveness. Specifically, elevations in reward sensitivity were linked to decision making patterns characterised by the gathering of less information, more uncertainty at the point of decision, less correct answers, and more errors. Given the decreasing-win condition of the IST places a penalty on information sampling, it appears that participants higher in reward sensitivity were highly motivated to win points on the IST, and thus modified their performance in order to maximise the potential points earned per trial. This pattern of results aligns with the understanding that the reward sensitive individual displays a hypersensitivity to rewarding stimuli, and thus exhibits greater motivation to acquire rewards in the environment (Dawe et al., 2004; Dawe & Loxton, 2004).

Associations between the two-factor model and reflection-impulsivity are novel findings, and indicate that impulsive temperament may influence patterns of decision making, particularly in conditions of reward contingency. Interestingly, comparisons made between high- and low-binge groups suggests that the strength of association between the two-factor model and reflection-impulsivity in the decreasing-win condition became stronger at higher levels of binge drinking. This pattern of results suggests that higher levels of binge drinking may strengthen the relationship between impulsive temperament and impulsive patterns of decision making. Although this finding is preliminary, it may be indicative of the alcohol related neurobiological processes that degrade the prefrontal regions, enhance impulsivity, and perpetuate further alcohol use (Bechara, 2005; Dawe et al., 2004; Jentsch & Taylor, 1999). Further research is needed in order to investigate patterns of reflection among the rash impulsive and reward sensitive individual, particularly in the context of substance misuse.
Exploring the Two-Factor Model and Binge Drinking

Given that a series of studies consistently report reward sensitivity and rash impulsiveness are relevant markers of risky drinking in young people without issues of addiction (Franken & Muris, 2006a; Gullo et al., 2010a; Gullo et al., 2010b; Harnett et al., 2013; Kabbani & Kambouropoulos, 2013; Lyvers et al., 2012), the finding that the two-factor model was not significantly associated with binge drinking or hazardous alcohol use was unexpected. This finding is inconsistent with a strong body of research, and suggests that the relationship between reward sensitivity, rash impulsiveness, and binge drinking is complex.

Historically, the two-factor model is primarily studied in the context of hazardous alcohol use, substance abuse, and addiction (e.g., Egan et al., 2010; Gullo et al., 2011; Harnett et al., 2013). Although binge drinking has received less attention in this field, there is empirical support that indicates the two-factor model may be relevant in understanding the binge pattern of drinking. Specifically, Franken and Muris (2006a) reported a significant association between BAS fun seeking, a measure indicative of reward sensitivity, and binge drinking frequency, where elevations in BAS fun seeking were linked to greater frequency of binge drinking. Similarly, Castellanos-Ryan et al. (2011) found that sensation seeking, or reward sensitivity, was uniquely related to binge drinking frequency in a sample of adolescents. It is possible that methodological and sample differences in the present study account for the unexpected findings.

Specifically, Franken and Muris (2006a) evaluated binge drinking frequency as a major outcome variable, using the Quantity-Frequency-Variability Index (Lemmens, Tan, & Knibbe, 1992). Similarly, Castellanos-Ryan et al. (2011) also reported binge drinking frequency as a major outcome. This variable
was collected based upon frequency of binge episodes reported over the past six months (a binge episode was five or more alcoholic drinks for males and four or more drinks for females in one occasion). In contrast, the current study reported a binge drinking score as the primary outcome variable that was a composite score comprising drinking speed, quantity, and frequency (Townshend & Duka, 2002). The binge drinking score reflects drinking patterns by incorporating speed of drinking, frequency of binge episodes and proportion of times getting drunk when drinking. As such, although the binge score incorporates frequency of binge episodes, the integration of additional information relating to drinking speed and proportion of times drunk may account for study differences.

Secondly, it is possible that sample characteristics account for inconsistent findings in the current research. Franken and Muris (2006a) carried out their study in a sample primarily comprised of undergraduate students in their late teens or early twenties. In addition, Castellanos-Ryan et al. (2011) recruited an adolescent sample that specifically targeted those who reported problems with substances and alcohol in order to enhance the distribution of those with problematic substance behaviour. The sample characteristics of the present study varied considerably to Franken and Muris (2006a) and Castellanos-Ryan et al. (2011). In the present study, participants were of older age, ranging between twenty and thirty-five years, and a majority of the sample had achieved a level of education equivalent to either honours or post-graduate degree. Consequently, it is likely that these samples are qualitatively different and vary considerably in drinking behaviour and binging compared to those recruited in Franken and Muris (2006a) and Castellanos-Ryan et al. (2011). Moreover, the study did not attempt to target heavier drinkers within the sample and thus, largely comprised participants
reporting low risk drinking. Although this enhances generalisability to the general population, it is possible that the proportion of lower level drinkers within the present sample may mask potential associations between impulsivity and patterns of drinking.

**Impulsivity in High- and Low-Binge Drinkers**

Although significant associations between impulsivity measures and alcohol use were not established, a comparison of high-and low-binge drinkers indicated that drinking severity is a relevant factor in the relationship between impulsivity and alcohol use. Specifically, evaluation of high- and low-binge drinkers through a median split of the AUQ binge score indicated that in low-binge drinkers, there were no significant links between any measure of impulsivity and binge drinking. However, the nature of these relationships changed among high binge drinkers, where reward sensitivity, and reflection-impulsivity each were significantly linked to binge drinking. Specifically, in the high-binge group, elevations in binge drinking were associated with greater reward sensitivity, reduced information sampling, more uncertainty at the point of decision, greater errors, and less correct decisions, in the decreasing-win condition of the IST.

This pattern of results indicates that drinking severity is highly relevant in understanding the links between impulsivity and alcohol misuse. This has been demonstrated by Maurage and colleagues, who report a dose effect exists between binge drinking and cerebral damage. Specifically, Maurage et al. (2012) investigated cerebral impairments in a sample of binge drinkers compared to daily drinkers. In this study, drinkers whose alcohol use was considered low-risk (drank regularly but never more than five drinks per occasion), displayed no prefrontal
impairments, whilst those who drank the same global amount of alcohol in a binge pattern exhibited impairments to cerebral functioning. In the context of the present study, it is possible that an association between binge drinking and impulsivity may not be apparent in lower-level drinkers, however, as the level of binge drinking increases, it appears that links between impulsivity and binge drinking become apparent.

Interestingly, the significant relationships between drinking and impulsivity emerged only in the AUQ binge score, whilst relationships between impulsivity and AUDIT scores remained non-significant. This finding provides support for the argument that the binge pattern of drinking is qualitatively different from global alcohol consumption. Given associations between impulsivity and AUDIT scores remained non-significant, even at higher levels of binge drinking, this indicates that the way in which impulsivity relates to drinking may vary, based upon the pattern of alcohol consumption.

**Study Strengths**

A number of strengths should be taken into account when interpreting the findings of the current study. Firstly, this is the first study to integrate the two-factor model with reflection-impulsivity in the context of binge drinking. This analysis offers a unique perspective into the decisional patterns of the rash impulsive and reward sensitive individual, and demonstrates that trait impulsivity plays a role in the way in which people make decisions.

Further, this study has utilised multiple modalities of impulsivity, including self-report, and cognitive measures, in order to investigate how the impulsive profile may relate to alcohol use. The self-report tools selected to
investigate domains of impulsivity, namely, the I7 and SPSRQ, are well established measures of rash impulsiveness and reward sensitivity, respectively, that have been widely utilised in studies of alcohol use.

In addition, the IST, used to measure reflection-impulsivity, is an emerging tool within studies of substance misuse, and is considered a superior and pure measure of reflection-impulsivity, as the task places no demands on visual processing and working memory (Clark et al., 2006). The use of behavioural measures in empirical research is considered advantageous as this modality provides a snap shot of real life behaviour in a given situation, rather than a report of what an individual thinks they might do (Cyders & Coskunpinar, 2011). Further, behavioural measures provide insights into underlying tendencies or processes without issues of face validity and self-report biases (Cyders & Coskunpinar, 2011). As such, the study methodology utilised is considered a strength of this thesis.

Limitations

There are some important limitations that should be taken into account when interpreting the findings of this study. Firstly, sample characteristics of participants recruited in this study may limit the generalisability of the present findings. Specifically, participants in this study were highly educated, where over half of the sample comprised those who had achieved either an honours or postgraduate qualification. As such, the proportion of participants who achieved a higher education is disproportionate of the general population. Consequently, it is possible that the characteristics of participants in this sample may vary considerably in relation to both impulsivity and patterns of drinking, compared to the general population.
A second limitation of this study relates to the issue of directionality. Given the study design was cross-sectional in nature, temporal inferences about the impulsivity – binge drinking relationship cannot be made. Although the current study has indicated that reflection-impulsivity may predict binge drinking behaviour in young people, conclusions cannot be made as to whether impulsive patterns of decision making lead to elevations in binge drinking. Empirical evidence indicates that elevations in impulsivity both precede, and are exacerbated by alcohol misuse (Courtney et al., 2012; George et al., 2010; Maurage et al., 2013). Thus, it is likely that an impulsive temperament may increase an individual’s vulnerability to alcohol misuse, which is then exacerbated by the neural degeneration that follows hazardous alcohol use. Longitudinal research designs may provide additional empirical support for this cycle, and to further understand the impact of binge drinking on impulsivity over time.

The use of self-report measures of alcohol use in the present study may present as an additional limitation to the present study. Specifically, empirical studies suggest that self-report measures of alcohol use can result in either an underestimation, as well as an overestimation of alcohol consumption (Stockwell et al., 2016). Issues such as social desirability and poor memory may be particularly relevant to the present sample. Specifically, those who engage in binge drinking are likely to have difficulty remembering specific quantities of alcohol consumed, where elevations in intoxication are likely to correspond with poorer recall. Further, participants may have displayed a tendency to underreport levels of drinking in order to present themselves in a positive light. It is thus possible that self-report biases and memory issues may have impacted upon the overall study findings. Despite these limitations, self-report measures of alcohol
use are primarily utilised within the literature. Future research may consider utilising tools such as diary recall techniques with detailed questions about drinking occasions, in order to cross-reference the validity of self-report measures.

Future Directions

This study provides preliminary support for the investigation of reflection-impulsivity together with the two-factor model. Further research is recommended to explore the decisional patterns of the rash impulsive and reward sensitive individual, particularly in populations identified as displaying elevations in these traits. Given reward sensitivity was particularly linked to decisional performance in the decreasing-win condition of the IST, future research is needed to corroborate the present findings. Further, future research may wish to investigate patterns of decision making across the reward sensitive continuum, in order to understand how variation within this trait may drive reflection-impulsivity.

Importantly, future research may benefit from investigating the two-factor model and reflection-impulsivity in clinical samples of heavy drinkers, those with issues of addiction, or substance misuse. There is empirical evidence that indicates that the two-factor model, and reflection-impulsivity, are each elevated within these groups (Clark et al., 2006; Gullo et al., 2011; Loxton et al., 2008a; Solowij et al., 2012). As such, investigation of these constructs within clinical samples may further explain how the impulsivity profile contributes to ongoing issues of substance misuse.
Conclusion

The present study explored the integration of reward sensitivity, rash impulsiveness, and reflection-impulsivity, in the prediction of binge drinking. On the basis of the present findings, evidence suggests that reflection-impulsivity is a significant predictor of binge drinking. Although the two-factor model was not associated with binge drinking or alcohol use, low rates of drinking in the study sample may account for the lack of significant findings. The data provides preliminary evidence that suggest higher levels of binge drinking may strengthen the relationship between an impulsive temperament and impulsive patterns of decision making. However, further research in this area is needed, particularly in samples of heavy and dependent drinkers.
CHAPTER EIGHT

Study Two: Examining Risk and Protective Factors of Binge Drinking

Overview

The previous chapter concluded that reflection-impulsivity was a significant predictor of binge drinking, that reward sensitivity was more strongly related to reflection-impulsivity compared to rash impulsiveness, and that the impulsive – alcohol use relationship becomes stronger among high-level binge drinkers.

This chapter will present the rationale, methodology, results, and discussion of the second study of this thesis. Drawing on findings reviewed in Chapter Four (Adams et al., 2013; Fernie et al., 2013; Mermelstein & Garske, 2015; Romer, 2010), this chapter will explore how risk taking and mindfulness relate to binge drinking and impulsivity, and how these domains may act to influence binge drinking. Specifically, this chapter aims to examine whether risk taking mediates the relationship between impulsivity and binge drinking. Further, the moderating role of mindfulness on reflection-impulsivity and binge drinking will be explored. Finally, given the overlapping theoretical processes between trait-mindfulness and reflection-impulsivity, a secondary aim of the present study is to examine the relationship between trait-mindfulness and reflection-impulsivity.

Rationale

Given many young people engage in binge drinking, it is important to delineate factors that enhance the likelihood of social binge drinking progressing
into disorders of addiction. As discussed in Chapter Three, whilst impulsivity is implicated in the development and maintenance of alcohol misuse and addiction (Dawe et al., 2004), there are a number of cognitive processes that may explain the association between alcohol use and impulsivity, such as alcohol expectancies and drinking refusal self-efficacy (Gullo et al., 2010a). These cognitive mediators help to explain the relationship between impulsivity and alcohol use, and highlight the relevance of both proximal, and distal factors, within alcohol and substance use behaviour. However, it is likely that additional factors may also play a role within this framework.

It is argued in this study that risk taking and trait mindfulness, may each contribute toward the relationship between impulsivity and alcohol use. This argument is based on empirical evidence that indicates both risk taking and trait mindfulness each correlate with, and conceptually relate to impulsivity (Murphy & MacKillop, 2012; Romer et al., 2016; Yarosh et al., 2014). Further, neurobiological research finds risk taking behaviour and trait-mindfulness each draw upon functions of the executive system, and each are associated with patterns of alcohol use (Adams et al., 2013; Alfonso, Caracuel, Delgado-Pastor, & Verdejo-García, 2011; Romer et al., 2016).

**Risk Taking**

Risk taking is characterised as behaviour intended to attain a desired reward with the potential for an undesirable result such as loss, danger, or harm (Bornovalova et al., 2009). Examples of risk taking behaviours include illicit drug use, unsafe sexual practices, dangerous driving or thrill seeking such as bungee jumping, or white water rafting (Boyer, 2006). Although risk taking is generally
recognised as a series of behaviours, individuals vary in their tendency to be risk taking or risk averse (Highhouse et al., 2016).

Given risk taking is characterised by a desire to seek rewards in light of potential losses or danger, it is unsurprising that this construct is a known correlate of impulsivity (Romer, 2010). A series of studies suggest that individual differences in impulsivity may influence the tendency to engage in risky behaviour (Bornovalova et al., 2009; Maher et al., 2015; Romer et al., 2016). Specifically, lower levels of trait impulsivity and sensation seeking relate to greater risk averse behaviour on the Balloon Analogue Risk Task (BART) (Bornovalova et al., 2009), whilst higher levels of rash impulsiveness and reward sensitivity predict greater engagement in risk taking behaviour, including drug and alcohol use, drink driving, and extreme sports such as downhill skiing, and parachuting (Maher et al., 2015; Romer et al., 2016). Importantly, preliminary research suggests that rash impulsiveness is associated with greater degree, or severity of risk taking, once engaged in a risky behaviour (Maher et al., 2015). These findings suggest that impulsive traits appear to influence the tendency to take, or avoid risks, where those higher in trait impulsivity are more likely to engage in a series of risky behaviour.

Neurobiological models of risk taking support links between impulsivity and risk taking, indicating that functioning of the prefrontal regions is associated with risk taking, or risk averse behaviour (Steinberg, 2008; van Duijvenvoorde et al., 2014). Specifically, functioning of the dorsolateral prefrontal, lateral orbitofrontal, and superior parietal cortices are associated with risky decision making and behaviour on simulated gambling tasks (van Duijvenvoorde et al., 2014; Worbe et al., 2014). Greater activation of these regions is associated with
greater risky decisions and behaviour, suggesting that functioning of these regions may account for individual variation in the disposition to take risks (van Duijvenvoorde et al., 2014; Worbe et al., 2014). In addition to risk taking, functioning of the prefrontal cortex is also associated with impulsivity, and is vulnerable to the neurotoxic effects of alcohol (Crews & Boettiger, 2009).

However, not all risk taking is impulsive. Risky behaviour and decision making may also be premeditated, deliberate, and based upon a cost-benefit analysis (Maslowsky et al., 2011). As such, although there is an overlap between risk taking and impulsivity, it is argued that they are distinct, yet related constructs. Given links between impulsivity, executive functions, and alcohol use, it is likely that risk taking is part of the complex and interrelated personality and behavioural patterns involved in binge drinking in young people.

In the context of alcohol use, empirical studies report links between elevated risk taking and greater alcohol use in young people (Miller et al., 2007; Stickley et al., 2013). Specifically, a series of studies suggest that young binge drinkers engage in higher rates of risky behaviour compared to non-binge drinkers (Miller et al., 2007; Stickley et al., 2013). In these studies, binge drinkers report higher rates of unsafe driving, engagement in risky sexual behaviour, drug use, physical violence and aggression, suggesting that binge drinking leads to greater prevalence of risk taking in young people (Miller et al., 2007; Stickley et al., 2013).

Further, empirical studies also suggest that the disposition to take risks may lead to greater alcohol use in young people (de Haan et al., 2015; Fernie et al., 2010; Fernie et al., 2013). For example, Fernie et al. (2010) reported that
greater behavioural risk taking on the BART significantly predicted increased alcohol use in a sample of young adults, and the unique variance in alcohol use predicted by risk taking was over and above that of trait impulsivity. Further, a prospective study investigating the predictive relationship of risk taking and alcohol use reported that behavioural risk taking on the BART significantly predicted alcohol use six months later (Fernie et al., 2013). Specifically, those who took greater risks on the BART reported greater frequency and quantity of alcohol six months later. Finally, de Haan et al. (2015) reported that university students who reported high self-reported risk taking, had increased odds of being a binge drinker, compared to a non-binge drinker or abstainer. Taken together, these findings suggest that although risk taking is related to impulsivity, it is a distinct construct that has an independent effect on alcohol use.

The aforementioned studies highlight that although risk taking is closely associated with trait impulsivity, it is a distinct construct that independently predicts alcohol use. Further, studies that investigate links between risk taking and alcohol use suggest that risk taking may both precede, and be exacerbated by binge drinking in young people. It is argued here that the disposition to take risks is directly associated with trait level impulsivity, and alcohol use. Specifically, it is argued that greater rash impulsiveness and reward sensitivity may be linked to greater risky behaviour, and this in turn may predict higher levels of binge drinking. The mediating effect of risk taking on rash impulsivity, reward sensitivity and binge drinking has not previously been explored. It is proposed that by investigating these relationships, the present study will provide additional insights into factors that may identify binge drinkers who are at risk of more problematic alcohol use.
Mindfulness

Although much empirical research attempts to identify risk factors in the development of alcohol misuse, it is equally important to consider factors that may protect against hazardous alcohol use in order to develop efficacious prevention and treatment interventions. Clinical evidence suggest that mindfulness is an effective intervention that promotes more adaptive alcohol use behaviour and treatment outcomes in alcohol and substance using populations (Mermelstein & Garske, 2015; Staiger et al., 2014). Mindfulness is defined as the awareness that emerges from focussing attention on the present moment with an attitude of acceptance and non-judgment (Kabat-Zinn, 2003). Mindfulness is a unique construct as it is proposed to occur both naturally within personality, and is also modifiable through the practice of mindfulness-based interventions (Carmody & Baer, 2008). Trait or dispositional mindfulness refers to the extent to which one is aware of, or attends to the present experience, independent of mindful practice (Brown & Ryan, 2003).

A series of studies suggest that mindfulness is a correlate of impulsivity, and that mindful processes overlap with executive functions (Lyvers, Makin, Toms, Thorberg, & Samios, 2013; Murphy & MacKillop, 2012; Peters et al., 2011). For example, research indicates that trait mindfulness is negatively associated with attentional, motor, and non-planning impulsivity, as measured by the Barratt Impulsiveness Scale (BIS-11) (Lattimore, Fisher, & Malinowski, 2011; Peters et al., 2011). Further, greater mindful awareness is linked to lower levels of sensation seeking, and is negatively associated with lack of premeditation and lack of perseverance (Murphy & MacKillop, 2012). Together, these findings suggest that increased awareness of the present moment may
enhance regulation of impulsive behaviour across multiple domains of impulsivity.

Associations between trait mindfulness and impulsivity are unsurprising, given a series of mindful processes overlap with a number of executive functions. Specifically, individuals with high levels of dispositional mindfulness are likely to have greater ability to sustain awareness of present moment experiences in a non-evaluative way (Short, Mazmanian, Oinonen, & Mushquash, 2016). It is argued that these processes are linked to attention, memory, and regulation of behaviour and emotions (Lyvers et al., 2013; Ostafin et al., 2013).

Importantly, neurobiological studies report that trait mindfulness is associated with enhanced working memory and inhibitory control (Riggs, Black, & Ritt-Olson, 2015), as well as reduced executive dysfunction and disinhibition (Lyvers et al., 2013). In addition to trait mindfulness, the practice of mindfulness is associated with improvements to working memory, response inhibition, selective attention, and decision making, when compared to those who do not practice mindfulness (Alfonso et al., 2011; Jha, Stanley, Kiyonaga, Wong, & Gelfand, 2010). Together, these studies suggest that mindful processes may overlap with functioning of the executive system, and this may lead to lower levels of impulsivity.

Further, it is argued in the present study that the processes of mindfulness that involve attention, resistance to distraction, and cognitive control are related to the reflective component of reflection-impulsivity. It is likely that these abilities may enable greater capacity for reflection and deliberation during decision making, leading to greater accuracy or adaptive choices. At present, only one
study has investigated mindfulness together with reflection-impulsivity using the Information Sampling Task (IST) (Valls-Serrano et al., 2016). In this study, a mindfulness-based intervention was compared to treatment as usual in a sample of polysubstance users. Greater levels of reflection were displayed in those who received the mindfulness-based intervention, demonstrated by greater information sampling, and less errors on the IST, compared to those in the control group. Further, pre-post assessment suggested that decisional patterns became more reflective in those who received the mindfulness intervention, specifically, participants opened significantly more boxes and made fewer errors on the IST following the mindfulness intervention, whilst reflective patterns in the control group were unchanged at the follow-up assessment. These findings suggest that mindful techniques, such as orientation to the present moment, allow for greater reflection and deliberation during the decision-making process.

Given links between trait-mindfulness, impulsivity, and executive functions, it is argued that mindfulness may be a relevant factor in regulating alcohol use behaviour (Leeman et al., 2014). Preliminary evidence supports this argument, specifically, trait mindfulness is associated with lower levels of alcohol consumption in young adults (Murphy & MacKillop, 2012), and lower severity of substance dependence in treatment seeking adults (Bowen & Enkema, 2014). In these studies, young adults who reported a higher disposition to not judge subjective experiences, nor to react to inner experiences, and to be experientially aware of experiences, reported lower levels of alcohol consumption, and lower negative consequences as a result of drinking (Murphy & MacKillop, 2012). In the treatment seeking adults, those who report the tendency to act consciously and with awareness, a greater ability to describe thoughts and feelings, and the ability
refrain from value judgements or self-criticism, reported a lower severity of substance dependence (Bowen & Enkema, 2014). These studies suggest that the disposition to be mindful, namely, to act with intention and purpose, to attend to the present moment in a non-judgemental and accepting way, may protect against problematic alcohol or substance use.

In the context of binge drinking, preliminary studies suggest that trait-mindfulness is associated with patterns of drinking that are more adaptive (Adams et al., 2013; Mermelstein & Garske, 2015). Specifically, Adams et al. (2013) reported that trait mindfulness was associated with fewer drinks consumed per week, fewer episodes of binge drinking in the past three months, and lower likelihood of alcohol use disorders. In addition to trait mindfulness, mindfulness-based interventions also play a role in binge drinking. Specifically, Mermelstein and Garske (2015) reported that a mindfulness-based intervention was associated with reduced binge drinking episodes, fewer negative consequences associated with alcohol use, and more adaptive drinking patterns. Importantly, the mindfulness-based intervention was not associated with fewer drinking occasions, suggesting that although participants continued to drink, the rate of drinking was reduced (Mermelstein & Garske, 2015). Taken together these results suggest that both trait-mindfulness and the practice of mindfulness may promote more adaptive patterns of drinking in young people.

Together, the aforementioned studies provide empirical support that trait mindfulness is associated with lower levels of impulsivity, alcohol use, and binge drinking behaviour. Although evidence supports these trends, it is preliminary in nature, particularly regarding binge drinking and reflection-impulsivity. It is argued in this study that trait mindfulness is directly associated to binge drinking
behaviour, and that it may be relevant in understanding the relationship between reflection-impulsivity and binge drinking. Specifically, it is predicted that high levels of trait mindfulness may weaken the relationship between reflection-impulsivity and binge drinking, as the tendency to attend to present moment experiences in a non-evaluative way may promote greater capacity for reflection during decision making, which may in turn lead to more adaptive patterns of drinking. As such the present study will evaluate trait-mindfulness as a moderator for the relationship between reflection-impulsivity and binge drinking, as the degree to which one pays attention to the present moment may shape the link between decisional patterns and drinking behaviour. Previous studies have not investigated trait-mindfulness as a moderator for reflection-impulsivity and binge drinking, thus, the present study may provide additional insights into how mindfulness may protect against binge drinking behaviour.

Further, it is possible that trait-mindfulness may help explain the relationship between impulsive disposition and patterns of decision making in young people. This argument is made based upon evidence that indicates trait-mindfulness is a correlate of trait-impulsivity, that impacts upon attentional and executive processes, known to play a role within decisional patterns (Galla, Hale, Shrestha, Loo, & Smalley, 2012; Riggs et al., 2015). As such, it is argued that the disposition to attend to present moment experiences may account for variance within the trait-impulsivity – cognitive impulsivity relationship. Previous research has not investigated associations between mindfulness, rash impulsiveness, reward sensitivity, and reflection-impulsivity. However, given findings of the aforementioned studies, it is possible that lower levels of rash impulsiveness and
reward sensitivity may be linked to higher levels of mindfulness, which may in turn predict greater reflective patterns in decision making.

**Summary**

In summary, the present study argues that risk taking and mindfulness are likely to predict binge drinking behaviour in a sample of young people. Specifically, it is argued that risk taking may enhance the risk of binge drinking behaviour, whilst trait mindfulness may act as a protective factor. Further, evaluation of risk taking and mindfulness together with the two-factor model, and reflection-impulsivity may provide new insights into how these factors drive alcohol use. As such, this study aims to evaluate the utility of risk taking and mindfulness in the prediction of binge drinking. A secondary aim of this study is to evaluate how risk taking and mindfulness relate to domains of impulsivity, and how these variables may underpin associations between impulsivity and binge drinking.

**Hypotheses**

1. It is hypothesised that risk taking will significantly and positively predict higher levels of binge drinking.
   a. It is hypothesised that risk taking will mediate the relationship between impulsivity (both rash-impulsivity and reward sensitivity) and binge drinking. Specifically, it is predicted that higher levels of rash impulsiveness and reward sensitivity will be associated with greater risk taking, which in turn will predict greater levels of binge drinking.

2. It is hypothesised that trait-mindfulness will be a significant negative predictor of binge drinking.
a. It is hypothesised that trait-mindfulness will moderate the relationship between reflection-impulsivity and binge drinking. Specifically, it is predicted that higher trait mindfulness will weaken the relationship between reflection-impulsivity and binge drinking.

3. It is hypothesised that trait-mindfulness will mediate the relationship between the two-factor model and reflection-impulsivity. Specifically, it is predicted that lower levels of rash impulsiveness and reward sensitivity be associated with increased trait-mindfulness, which in turn will predict greater levels of reflection, as measured by the IST.
Method

Methodology for the current study is presented in Chapter Six. Please refer to this chapter for information regarding the study sample, materials, and procedure. In this study, measures included to test the hypotheses were participant demographics, the Information Sampling Task (IST), the Automatic-Balloon Analogue Risk Task (BART-A), the Domain Specific Risk Task (DSRT), Kentucky Inventory of Mindfulness Skills (KIMS), the Alcohol Use Questionnaire AUQ, the Alcohol Use Disorders Identification Test AUDIT, the Eysenck Questionnaire (I7), and the sensitive to reward subscale from the Sensitive to Reward Sensitive to Punishment Questionnaire (SPSRQ).

The IST variables used to assess reflection-impulsivity include boxes opened, total correct points, p-correct (probability of being correct at the point of decision), sampling errors (selection of colour in majority at time of decision, but not in the majority overall), discrimination errors (selection of the colour in the minority at time of decision), and response latency as a measure of reflection-impulsivity. Risk taking variables include the BART-A and the DSRT risk taking domains. The BART-A score reflects the average number of wanted pumps across BART-A trials, a greater score reflects greater behavioural risk taking on the task. The DSRT, financial decisions, health and safety, recreational, ethical, and social decisions, reflect the likelihood of engaging in risk taking across these domains, where higher scores reflect greater degree of risk taking. Trait-mindfulness variables include the KIMS total, observing, describing, acting with awareness, and accepting without judgement. Scores on these domains reflect the tendency to engage in mindful skills in daily life. Binge drinking is a composite
score made up of three items on the AUQ that reflect drinking frequency, quantity and binge frequency. Whilst the AUDIT variables provide a measure of hazardous alcohol use (AUDIT Total score), alcohol consumption, dependence, and problems relating to alcohol use. Finally, the I7 provides a measure of rash impulsiveness, and the SPSRQ score reflects reward sensitivity.

**Statistical Analysis**

Statistical Package for Social Sciences (SPSS) version 22 was used for preliminary data analysis and hypothesis testing. Pearson’s correlation coefficient was calculated to identify the relationships between risk taking, mindfulness, impulsivity, binge drinking, and alcohol use. Path analysis was used to evaluate regression pathways between impulsive domains, mindfulness, risk-taking, and alcohol use. All model estimations were conducted with Analysis of Moment Structures (AMOS) version 22 using maximum-likelihood estimation (Tabachnick & Fidell, 2013). Mediation was conducted using the PROCESS add-on to SPSS, version 2.15 (Hayes, 2013).

**Path Analysis Data Treatment**

The primary focus of path analysis was to evaluate regression pathways to examine the relationships among variables, and to evaluate the extent to which relationships were mediated by hypothesised variables. The standardised indirect effects were examined to assess mediation models, and were tested for significance using the Bootstrap estimation procedure in AMOS. Mediation was supported when 95% confidence intervals did not pass through zero, indicating a statistically significant effect (Tabachnick & Fidell, 2013). Model fit was evaluated using the fit indices: Chi-square, Comparative Fit Index (CFI), Tucker-Lewis Coefficient (TLI), Root Mean Square Error of Approximation (RMSEA)
and Standardised Root Mean Square Residual (SRMR). These indices were chosen based upon guidance from Tabachnick and Fidell (2013), who suggest reporting multiple indices, and deem the CFI to be unaffected by sample size. To evaluate the overall goodness of fit, criteria for the path analysis included: a non-significant Chi-square, values greater than .95 for CFI and TLI, and values of .06 and .08 for RMSEA and SRMR, respectively (Tabachnick & Fidell, 2013).
Results

Preliminary Data Analysis

Analysis of missing data was conducted, there was one case with all self-report data missing due to a computer malfunction, which was deleted from the database. No other cases were deleted due to missing data. There were 2% missing values across the dataset and less than 5% missing data on any item. Data missing at random was replaced with the series mean (Tabachnick & Fidell, 2013).

Variables were examined for deviations from normality, univariate and multivariate outliers. Univariate outliers were identified as cases with a large standardised score greater than 3.29 \( (p < .001) \) (Tabachnick & Fidell, 2013). There were 11 univariate outliers identified using this criterion, seven univariate outliers emerged from the IST; the I\(^7\), DSRT, AUDIT, and BART-A each contained one outlier. To reduce the impact of extreme scores, outliers were re-coded a raw score that was one unit greater or smaller than the next most extreme score within 3.29 standard deviations from the mean (Tabachnick & Fidell, 2013). This technique allows outlying cases to remain in the dataset, however reduces their impact (Tabachnick & Fidell, 2013). All variables were assessed for multivariate outliers using the criterion \( p < .001 \) (Tabachnick & Fidell, 2013). Mahalanobis distance reported two multivariate outliers which were higher than the critical value \( (\chi^2 = 58.301, \text{df} = 29) \). These outliers were deleted from the dataset. Therefore, the total sample included in the analysis was \( N = 98 \).

Variables were screened for normality using Shapiro Wilks statistics. The KIMS, AUDIT, I\(^7\), and SPSRQ were normally distributed at \( p > .001 \), while all
IST variables, AUQ, and the DSRT were skewed at the $p < .001$ criterion. Tabachnick and Fidell (2013) specify that normality statistics are highly sensitive in large sample sizes, and that violations in skewness and kurtosis have little impact upon analyses (Tabachnick & Fidell, 2013). Examination of absolute skewness and kurtosis statistics indicate that there were no severe distribution violations (see Table 8.1). Transforming data as a remedy for failures of normality can lead to difficulty interpreting the data, and is universally not recommended (Tabachnick & Fidell, 2013). Given these factors, data transformation was not performed to prevent difficulty with data interpretation and generalisability. In summary, all variables included in the hypothesis testing have distributions indicative of the general population and contain no univariate or multivariate outliers ($p < .001$).
Table 8.1.

*Skewness and Kurtosis Indices for both Independent and Outcome Variables*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Skew ($SE = .24$)</th>
<th>Kurtosis ($SE = .48$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I⁷</td>
<td>.49</td>
<td>-.58</td>
</tr>
<tr>
<td>SPSRQ</td>
<td>.40</td>
<td>-1.15</td>
</tr>
<tr>
<td>IST FW Boxes Opened</td>
<td>-.24</td>
<td>-1.15</td>
</tr>
<tr>
<td>IST FW P-Correct</td>
<td>-.21</td>
<td>-1.14</td>
</tr>
<tr>
<td>IST FW Total Correct</td>
<td>-.96</td>
<td>.89</td>
</tr>
<tr>
<td>IST FW Sampling Error</td>
<td>1.68</td>
<td>3.45</td>
</tr>
<tr>
<td>IST FW Discrimination Error</td>
<td>1.32</td>
<td>1.50</td>
</tr>
<tr>
<td>IST FW Latency</td>
<td>1.06</td>
<td>.82</td>
</tr>
<tr>
<td>IST DW Boxes Opened</td>
<td>.87</td>
<td>.35</td>
</tr>
<tr>
<td>IST DW P-Correct</td>
<td>.89</td>
<td>.74</td>
</tr>
<tr>
<td>IST DW Total Correct</td>
<td>-.28</td>
<td>-.79</td>
</tr>
<tr>
<td>IST DW Sampling Error</td>
<td>.52</td>
<td>-.51</td>
</tr>
<tr>
<td>IST DW Discrimination Error</td>
<td>1.40</td>
<td>1.16</td>
</tr>
<tr>
<td>IST DW Latency</td>
<td>.60</td>
<td>.18</td>
</tr>
<tr>
<td>BART-A</td>
<td>-.22</td>
<td>1.17</td>
</tr>
<tr>
<td>DSRT Total</td>
<td>.31</td>
<td>-.48</td>
</tr>
<tr>
<td>DSRT Ethical</td>
<td>.59</td>
<td>.19</td>
</tr>
<tr>
<td>DSRT Financial</td>
<td>.43</td>
<td>-.15</td>
</tr>
<tr>
<td>DSRT Health/Safety</td>
<td>.70</td>
<td>.14</td>
</tr>
<tr>
<td>DSRT Recreational</td>
<td>.23</td>
<td>-1.03</td>
</tr>
<tr>
<td>DSRT Social</td>
<td>-.51</td>
<td>-.04</td>
</tr>
<tr>
<td>KIMS Total</td>
<td>.18</td>
<td>.77</td>
</tr>
<tr>
<td>KIMS Observe</td>
<td>.12</td>
<td>.63</td>
</tr>
<tr>
<td>KIMS Describe</td>
<td>-.13</td>
<td>-.06</td>
</tr>
<tr>
<td>KIMS Awareness</td>
<td>-.10</td>
<td>-.14</td>
</tr>
<tr>
<td>KIMS Acceptance</td>
<td>-.06</td>
<td>-.03</td>
</tr>
<tr>
<td>AUDIT</td>
<td>.44</td>
<td>-.20</td>
</tr>
<tr>
<td>AUQ Binge</td>
<td>.83</td>
<td>-.01</td>
</tr>
</tbody>
</table>

*Note. N=98; SE = Standard Error; I⁷ = Rash Impulsiveness, SPSRQ = Reward Sensitivity; IST FW = Fixed-win condition of the Information Sampling Task; IST DW = Decreasing-win condition of the Information Sampling Task; BART-A = Average Wanted Pumps on the Automatic Balloon Analogue Risk Task; DSRT = Domain Specific Risk-Taking Scale; KIMS = Kentucky Inventory of Mindfulness Skills; AUDIT = Alcohol Use Disorders Identification Test; AUQ = Alcohol Use Questionnaire*
Descriptive Statistics

Means, standard deviations, and internal consistency data for the self-report variables are presented in Table 8.2. As shown, all measures have acceptable to very high internal consistency with the exception the risk-taking domains: ethical, financial, and health/safety. Alpha levels for the DSRT domains ethical, financial, and health/safety were lower than the those found in the normative sample (.75, .71, and .86 respectively; Blais & Weber, 2006). Alpha levels reported in studies utilising the DSRT range between $\alpha = .51$ to .86 for the ethical domain, $\alpha = .66$ to .83, for the financial domain, and .60 to .72 for health/safety; across each of these studies the health/safety was the least reliable (Courtney et al., 2012; Highhouse et al., 2016; Schwartz et al., 2013; Soane, Dewberry, & Narendran, 2010; Weller, Ceschi, & Randolph, 2015; Wu & Cheung, 2014).

The composite AUQ binge score, made up of three alcohol use items, is considered a valid measure of binge drinking, it has been shown to correlate with diary records of drinking over the past month (Townshend & Duka, 2002). In the present study, the AUQ binge score significantly correlated with the AUDIT total ($r = .58, p < .001$), AUDIT consumption ($r = .60, p < .001$), AUDIT dependence ($r = .41, p < .001$), and AUDIT alcohol-related problems ($r = .35, p < .001$).

The means, standard deviations, and range data for behavioural measures are illustrated below in Table 8.3.
Table 8.2.
*Descriptive Statistics and Reliability Coefficients for Self-Report Questionnaires*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum Score</th>
<th>Maximum Score</th>
<th>Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>I^7</td>
<td>4.74</td>
<td>3.43</td>
<td>0</td>
<td>17</td>
<td>.75</td>
</tr>
<tr>
<td>SPSRQ</td>
<td>7.10</td>
<td>3.70</td>
<td>0</td>
<td>16</td>
<td>.78</td>
</tr>
<tr>
<td>DSRT Total</td>
<td>98.20</td>
<td>22.46</td>
<td>50</td>
<td>146</td>
<td>.84</td>
</tr>
<tr>
<td>Ethical</td>
<td>16.67</td>
<td>4.85</td>
<td>6</td>
<td>29</td>
<td>.53</td>
</tr>
<tr>
<td>Financial</td>
<td>14.32</td>
<td>5.50</td>
<td>6</td>
<td>33</td>
<td>.60</td>
</tr>
<tr>
<td>Health/Safety</td>
<td>19.22</td>
<td>6.39</td>
<td>8</td>
<td>39</td>
<td>.57</td>
</tr>
<tr>
<td>Recreational</td>
<td>21.28</td>
<td>9.74</td>
<td>6</td>
<td>42</td>
<td>.84</td>
</tr>
<tr>
<td>Social</td>
<td>29.63</td>
<td>6.59</td>
<td>10</td>
<td>41</td>
<td>.76</td>
</tr>
<tr>
<td>AUDIT</td>
<td>7.75</td>
<td>4.49</td>
<td>0</td>
<td>20</td>
<td>.77</td>
</tr>
<tr>
<td>Consumption</td>
<td>4.72</td>
<td>2.41</td>
<td>0</td>
<td>10</td>
<td>.72</td>
</tr>
<tr>
<td>Dependence</td>
<td>.99</td>
<td>1.06</td>
<td>0</td>
<td>5</td>
<td>.78</td>
</tr>
<tr>
<td>Problems</td>
<td>2.03</td>
<td>1.99</td>
<td>0</td>
<td>8</td>
<td>.71</td>
</tr>
<tr>
<td>KIMS</td>
<td>124.85</td>
<td>14.32</td>
<td>83</td>
<td>171</td>
<td>.84</td>
</tr>
<tr>
<td>Observe</td>
<td>39.73</td>
<td>7.39</td>
<td>19</td>
<td>60</td>
<td>.84</td>
</tr>
<tr>
<td>Describe</td>
<td>28.79</td>
<td>5.48</td>
<td>12</td>
<td>40</td>
<td>.81</td>
</tr>
<tr>
<td>Awareness</td>
<td>28.92</td>
<td>5.46</td>
<td>15</td>
<td>42</td>
<td>.78</td>
</tr>
<tr>
<td>Acceptance</td>
<td>28.59</td>
<td>6.60</td>
<td>11</td>
<td>44</td>
<td>.86</td>
</tr>
</tbody>
</table>

*Note.* N = 98; SD = Standard Deviation; I^7 = Rash Impulsiveness; SPSRQ = Reward Sensitivity; DSRT = Domain Specific Risk Taking Scale; AUDIT = Alcohol Use Disorders Identification Test; KIMS = Kentucky Inventory of Mindfulness Skills
Table 8.3.

Descriptive Statistics for Behavioural Measures

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum Score</th>
<th>Maximum Score</th>
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<td>Total Correct</td>
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<td>Discrimination Errors</td>
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</table>

Note. N = 98; SD = Standard Deviation; BART-A = Average Wanted Pumps on the Automatic Balloon Analogue Risk Task; IST = Information Sampling Task
**Interrelationships**

Bivariate correlational analyses were conducted to investigate the relationships among outcome variables. Due to the large number of correlations presented, there is a risk of Type-1 error. However, due to the preliminary nature of the study, the criterion $p < .05$ will be used for significance, thus results should be interpreted with caution. Several significant associations emerged between risk taking variables. Specifically, behavioural risk taking, as measured by the BART-A, significantly correlated with binge drinking ($r = .31, p < .01$), alcohol use ($r = .22, p < .05$), boxes opened ($r = -.26, p < .01$) and p-correct ($r = -.28, p < .01$) in the decreasing-win condition. Total risk taking as measured by the DSRT significantly correlated with both rash impulsiveness ($r = .43, p < .01$), reward sensitivity ($r = .28, p < .01$), and was negatively correlated with boxes opened ($r = -.29, p < .01$), p-correct ($r = -.26, p < .05$), and total correct ($r = -.25, p < .05$) in the decreasing-win condition. The health and safety domain of risk taking significantly correlated with rash impulsiveness ($r = .35, p < .01$), reward sensitivity ($r = .28, p < .01$), binge drinking ($r = .36, p < .01$) and alcohol use ($r = .38, p < .01$). In addition, the health and safety domain significantly and negatively correlated with boxes opened ($r = -.31, p < .01$), p-correct ($r = -.28, p < .01$), and total correct ($r = -.32, p < .01$), and positively correlated with sampling error ($r = .33, p < .01$), in the decreasing-win condition.

In addition, there were several significant associations between trait-mindfulness and domains of impulsivity. Specifically, total trait-mindfulness significantly and negatively correlated with rash impulsiveness and reward sensitivity ($r = -.32, p < .01$) and ($r = -.30, p < .01$), respectively. Mindful observing was significantly and negatively correlated with boxes-opened ($r = -
.26, \( p < .05 \)), p-correct (\( r = -.26, \ p < .01 \)), and positively correlated with sampling errors (\( r = .21, \ p < .05 \)), and latency (\( r = .22, \ p < .05 \)) in the fixed-win condition. This pattern was not replicated in the decreasing-win condition. In addition, mindful acceptance was significantly and positively associated with boxes opened (\( r = .20, \ p < .05 \)), p-correct (\( r = .23, \ p < .05 \)), and total correct (\( r = .20, \ p < .05 \)) in the fixed-win condition, and negatively correlated with rash impulsiveness (\( r = -.22, \ p < .05 \)) and reward sensitivity (\( r = -.34, \ p < .01 \)). Significant correlations also emerged between mindful acceptance and boxes opened (\( r = .22, \ p < .05 \)), p-correct (\( r = .21, \ p < .05 \)), total correct (\( r = .29, \ p < .01 \)), and sampling errors (\( r = -.33, \ p < .01 \)) in the decreasing-win condition. Bivariate correlations are displayed in Tables 8.4, 8.5, 8.6, and 8.7.
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<th>Variables</th>
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<th>3.</th>
<th>4.</th>
<th>5.</th>
<th>6.</th>
<th>7.</th>
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*Note. N = 98; Boxes O = Boxes Opened; Tot Corr = Total Correct; Sampling = Sampling Error; Discrim. = Discrimination Error; BART-A = Average Wanted Pumps on the Automatic Balloon Risk Task; DSRT-T = Domain Specific Risk Taking Total Score; Finance = Financial Risk Taking; Hea/Saf = Health and Safety Risk Taking; Recre = Recreational Risk-Taking; *p<.05, **p<.01; Correlations displayed above the grey line include reflection-impulsivity decreasing-win variables, and those below the line are reflection-impulsivity fixed-win condition variables.
Table 8.5.
Correlations Between Risk Taking and Reflection-Impulsivity in the Fixed- and Decreasing-Win Condition

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<th>AUQ</th>
<th>AUDIT</th>
<th>BART-A</th>
<th>DSRT Total</th>
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<th>Finance</th>
<th>Health</th>
<th>Safety</th>
<th>Recr.</th>
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</table>

Note. N = 98; $I^7$ = Rash Impulsiveness; SPSRQ = Reward Sensitivity; Samp. Err = Sampling Error; Discim. Err = Discrimination Error; BART-A = Average Wanted Pumps on the Automatic Balloon Risk Task; DSRT = Domain Specific Risk Taking Scale; Finance. = Financial Risk Taking; Hea/Saf = Health and Safety Risk Taking; Recre = Recreational Risk-Taking; *p < .05, **p < .01
Table 8.6.
Bivariate Correlations Between Reflection-Impulsivity in the Fixed- and Decreasing-Win Condition and Trait-Mindfulness

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<tr>
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<th>Total Correct</th>
<th>Samp. Error</th>
<th>Discrim. Error</th>
<th>Latency</th>
<th>KIMS Total</th>
<th>Observe</th>
<th>Describe</th>
<th>Aware</th>
<th>Accept</th>
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<td>.778**</td>
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<td>-.426**</td>
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Note. N = 98; Boxes O = Boxes Opened; Sampling = Sampling Error; Discrim. = Discrimination Error; KIMS-T = Kentucky Inventory of Mindfulness Skills Total Score; Correlations displayed above the grey line include reflection-impulsivity decreasing-win variables, and those below the line are reflection-impulsivity fixed-win condition variables; *p<.05, **p<.01.
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<th>AUDIT</th>
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</tbody>
</table>

Note. N = 98; Ι’ = Rash Impulsiveness; SPSRQ = Reward Sensitivity; AUQ = Alcohol Use Questionnaire; AUDIT = Alcohol Use Disorders Identification Test; KIMS = Kentucky Inventory of Mindfulness Skills; *p<.05, **p<.01
Hierarchical Regression

Hierarchical regression was used to assess the hypothesis that risk taking will significantly predict higher levels of binge drinking. Given impulsivity is a known correlate of risk taking, rash impulsiveness and reward sensitivity were entered at step one. The outcome variable was binge drinking, using the AUQ binge drinking score, and the independent variables were behavioural risk taking, using the BART-A average score, and the DSRT risk taking domains ethical, financial, health and safety, recreational, and social. Table 8.8 displays the unstandardized regression coefficients, and the standardised regression coefficients.
Table 8.8.

Hierarchical Regression of the two-factor model and reflection-impulsivity on binge drinking

<table>
<thead>
<tr>
<th>Variables</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower</td>
<td>Upper</td>
</tr>
<tr>
<td>Step 1 ($R^2 = .05$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rash Impulsiveness</td>
<td>.368</td>
<td>.394</td>
<td>.108</td>
<td>-.414</td>
<td>1.149</td>
</tr>
<tr>
<td>Reward Sensitivity</td>
<td>.439</td>
<td>.349</td>
<td>.145</td>
<td>-.254</td>
<td>1.133</td>
</tr>
<tr>
<td>Step 2 ($R^2 = .23$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rash Impulsiveness</td>
<td>.130</td>
<td>.395</td>
<td>.038</td>
<td>-.654</td>
<td>.914</td>
</tr>
<tr>
<td>Reward Sensitivity</td>
<td>.397</td>
<td>.348</td>
<td>.131</td>
<td>-.294</td>
<td>1.089</td>
</tr>
<tr>
<td>BART-A</td>
<td>.224</td>
<td>.096</td>
<td>.231</td>
<td>.033</td>
<td>.415</td>
</tr>
<tr>
<td>DSRT Ethical</td>
<td>-.270</td>
<td>.275</td>
<td>-.114</td>
<td>-.817</td>
<td>.276</td>
</tr>
<tr>
<td>DSRT Financial</td>
<td>-.154</td>
<td>.223</td>
<td>-.074</td>
<td>-.598</td>
<td>.290</td>
</tr>
<tr>
<td>DSRT Health/Safety</td>
<td>.614</td>
<td>.203</td>
<td>.348</td>
<td>.210</td>
<td>1.018</td>
</tr>
<tr>
<td>DSRT Recreational</td>
<td>-.187</td>
<td>.135</td>
<td>-.160</td>
<td>-.455</td>
<td>.081</td>
</tr>
<tr>
<td>DSRT Social</td>
<td>.138</td>
<td>.184</td>
<td>.081</td>
<td>-.227</td>
<td>.503</td>
</tr>
</tbody>
</table>

*Note.* B = Unstandardised Coefficient; SE B = Standard Error of B; β = Standardised Coefficient; CI = Confidence Interval; P = Probability; BART-A = Average Wanted Pumps on the Automatic Balloon Analogue Risk Task; DSRT = Domain Specific Risk Task Scale.

At step one, both rash impulsiveness and reward sensitivity explained 5% of the variance in binge drinking. After entry of the BART-A behavioural risk taking and DSRT domains at step two, the total variance explained by the model as a whole was 23%, and the additional variance explained was statistically
significant ($F (4, 91) = 3.31, p = .002$). The risk-taking measures explained an additional 14% of the variance in binge drinking, after controlling for impulsivity ($R^2$ change = .14, $F$ change (4, 91) = 3.53, $p = .004$). In this model, BART-A behavioural risk taking and the DSRT health and safety domain significantly predicted unique variance in binge drinking ($t (91) = 2.36, p < .05$), and ($t (91) = 3.02, p < .01$), respectively. The remaining risk-taking domains did not significantly predict binge drinking. This pattern of results supports the first hypothesis, where multiple measures of risk taking significantly predicted binge drinking.

**Path Analysis**

Path analysis was used to test the secondary hypothesis, that risk taking will mediate the relationship between rash impulsiveness, reward sensitivity, and alcohol use. Based upon significant correlations between the risk-taking variables, health/safety and BART-A and binge drinking, these variables, were included in the model as mediators. The AUQ binge and AUDIT total, were included as dependent variables. The hypothesised model is displayed in Figure 8.1.
Evaluation of the fit indices revealed the model was a moderate fit to the data, with the exception of the RMSEA index which is indicative of poor fit ($\chi^2(1, N = 96) = 4.33$, $p = .04$; CFI = .94 and RMSEA = .18). The hypothesised model accounted for 17% of the variance in binge drinking. There were three statistically significant pathways in this model. Specifically, rash impulsiveness had a significant direct effect on health and safety risk taking ($\beta = .27$, $p = .011$), and both health and safety risk taking, and BART-A risk taking significantly predicted binge drinking ($\beta = .28$, $p = .005$), and ($\beta = .22$, $p = .019$), respectively. Remaining path estimates are presented in Table 8.9.
To test for mediation, the combined indirect effects for risk-taking, namely, BART-A and Health/Safety Risk taking, were examined and tested for significance using the Bootstrap estimation procedure in AMOS. Table 8.10 displays the direct and indirect effects and their associated 95% confidence intervals. There was one significant indirect effect in the model. Specifically, the indirect effect of rash impulsiveness on binge drinking through risk taking was statistically significant (\( \beta = .12, p = .01 \)). The indirect effect of reward sensitivity on binge drinking via risk taking was not statistically significant. This pattern of results provides partial support for the hypothesis, as risk taking significantly mediated the relationship between rash impulsiveness and binge drinking.
Table 8.10.

*Indirect effects of risk taking on the relationship between rash impulsivity, reward sensitivity and binge drinking*

<table>
<thead>
<tr>
<th>Paths</th>
<th>Indirect Effect</th>
<th>SE</th>
<th>95% CI Lower Bounds</th>
<th>95% CI Upper Bounds</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>RI → Risk Taking → Binge Drinking</td>
<td>.388</td>
<td>.191</td>
<td>.019</td>
<td>.224</td>
<td>.010</td>
</tr>
<tr>
<td>RS → Risk Taking → Binge Drinking</td>
<td>.158</td>
<td>.149</td>
<td>-.033</td>
<td>.138</td>
<td>.304</td>
</tr>
</tbody>
</table>

*Note.* SE = Indirect Effects Standard Error; CI = Confidence Interval; P = Probability; RI = Rash Impulsiveness; Risk Taking = combined indirect effect for BART-A and Health/Safety Risk Taking variables

**Hierarchical Regression**

To test the second hypothesis, that mindfulness will significantly predict lower levels of binge drinking, hierarchical regression analysis was conducted. The dependent variable was binge drinking, using the AUQ binge drinking score. At step one, rash impulsiveness and reward sensitivity were entered to control for the impact of trait impulsivity on binge drinking. At step two, the independent variables were mindful observing, describing, awareness, and mindful acceptance without judgement. Table 8.11 displays the unstandardized regression coefficients, and the standardised regression coefficients.
Table 8.11.

Multiple Regression of the two-factor model and reflection-impulsivity on binge drinking

<table>
<thead>
<tr>
<th>Variables</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lower</td>
<td>Upper</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 1 ($R^2 = .05$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rash Impulsiveness</td>
<td>.368</td>
<td>.394</td>
<td>.108</td>
<td>-.414 - 1.149</td>
<td>.353</td>
</tr>
<tr>
<td>Reward Sensitivity</td>
<td>.439</td>
<td>.349</td>
<td>.145</td>
<td>-.254 - 1.133</td>
<td>.211</td>
</tr>
<tr>
<td>Model 2 ($R^2 = .07$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rash impulsiveness</td>
<td>.278</td>
<td>.411</td>
<td>.081</td>
<td>-.537 - 1.094</td>
<td>.500</td>
</tr>
<tr>
<td>Reward Sensitivity</td>
<td>.305</td>
<td>.307</td>
<td>.101</td>
<td>-.430 - 1.040</td>
<td>.412</td>
</tr>
<tr>
<td>KIMS Observe</td>
<td>.015</td>
<td>.167</td>
<td>.010</td>
<td>-.316 - .346</td>
<td>.929</td>
</tr>
<tr>
<td>KIMS Describe</td>
<td>-.178</td>
<td>.226</td>
<td>-.087</td>
<td>-.627 -.272</td>
<td>.434</td>
</tr>
<tr>
<td>KIMS Awareness</td>
<td>-.025</td>
<td>.236</td>
<td>-.012</td>
<td>-.949 -.443</td>
<td>.914</td>
</tr>
<tr>
<td>KIMS Acceptance</td>
<td>-.223</td>
<td>.189</td>
<td>-.131</td>
<td>-.598 .153</td>
<td>.242</td>
</tr>
</tbody>
</table>

Note. B = Unstandardised Coefficient; SE B = Standard Error of B; β = Standardised Coefficient; CI = Confidence Interval; P = Probability

At step one, rash impulsiveness together with reward sensitivity accounted for 5% of the variance in binge drinking. This contribution was not statistically significant ($F (2, 93) = 232, p = 10$). Neither rash impulsiveness nor reward sensitivity uniquely predicted binge drinking ($t (93) = .934, p = .35$), and ($t (93) = 1.258, p = .21$), respectively. The addition of mindfulness variables at step two explained a further 2% of the variance in binge drinking, this did not significantly improve the predictive variance in binge drinking ($F (6, 98) = 1.148, p = .31$). As displayed in the above Table 8.11, none of the mindfulness domains significantly
predicted binge drinking. Taken together, this pattern of results does not support the hypothesis, as trait level mindfulness did not significantly predict binge drinking.

**Moderation**

Moderation analyses was conducted to assess whether mindfulness moderated the relationship between IST performance and binge drinking. Three models were tested, in each model the dependent variable was AUQ Binge score, and the moderator variable was KIMS Acceptance. KIMS Acceptance was chosen as the moderating variable based on statistical reasoning, namely, KIMS Acceptance consistently correlates with both IST and self-report impulsive variables (see Tables 8.6 and 8.7). For the first model, the independent variable was FW boxes opened, in Model Two, the independent variable was rash impulsiveness, and in Model Three, the independent variable was reward sensitivity.

Table 8.12 displays the moderation coefficients and 95% confidence intervals. In Model One, 4% of the variance in binge drinking was explained by reflection-impulsivity and mindful acceptance, however, this was not statistically significant (F (3, 95) = 1.71, p = .32). Moderation is shown by a significant interaction effect (Field, 2013). The interaction between mindfulness and reflection-impulsivity was not significant (b = .01, (3, 95) t = .282, p = .78), indicating that mindful acceptance did not moderate the relationship between reflection-impulsivity and binge drinking. This pattern of results suggests that the relationship between reflection-impulsivity, as measured by the IST, and binge drinking, does not change as a product of trait mindfulness.
Table 8.12.

*Moderation analysis of IST Performance on Binge Drinking, moderated by Mindfulness*

<table>
<thead>
<tr>
<th>Model</th>
<th>$R^2$</th>
<th>$F$ (3, 95/92/94)</th>
<th>$p$</th>
<th>95% CI Lower</th>
<th>95% CI Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 1</td>
<td>$=.04$, $F (3, 95) = 1.71, p = .32$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>15.63</td>
<td>1.16</td>
<td>.000</td>
<td>13.32</td>
<td>17.95</td>
</tr>
<tr>
<td>KIMS Accept</td>
<td>-.34</td>
<td>.21</td>
<td>.10</td>
<td>-.77</td>
<td>.07</td>
</tr>
<tr>
<td>FW Boxes Opened</td>
<td>.21</td>
<td>.19</td>
<td>.29</td>
<td>-.18</td>
<td>.60</td>
</tr>
<tr>
<td>Interaction</td>
<td>.01</td>
<td>.03</td>
<td>.78</td>
<td>-.06</td>
<td>.08</td>
</tr>
<tr>
<td>Model 2</td>
<td>$=.08$, $F (3, 92) = 3.28, p = .02$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>16.07</td>
<td>1.22</td>
<td>.000</td>
<td>13.64</td>
<td>18.49</td>
</tr>
<tr>
<td>KIMS Accept</td>
<td>-.30</td>
<td>.19</td>
<td>.13</td>
<td>-.68</td>
<td>.08</td>
</tr>
<tr>
<td>Rash Impulsiveness</td>
<td>.55</td>
<td>.45</td>
<td>.22</td>
<td>-.33</td>
<td>1.43</td>
</tr>
<tr>
<td>Interaction</td>
<td>.08</td>
<td>.09</td>
<td>.37</td>
<td>-.09</td>
<td>.25</td>
</tr>
<tr>
<td>Model 3</td>
<td>$=.07$, $F (3, 94) = 2.66, p = .05$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>16.15</td>
<td>1.32</td>
<td>.000</td>
<td>13.52</td>
<td>18.78</td>
</tr>
<tr>
<td>KIMS Accept</td>
<td>-.26</td>
<td>.22</td>
<td>.23</td>
<td>-.70</td>
<td>.17</td>
</tr>
<tr>
<td>Reward Sensitivity</td>
<td>.49</td>
<td>.43</td>
<td>.25</td>
<td>-.36</td>
<td>1.33</td>
</tr>
<tr>
<td>Interaction</td>
<td>.05</td>
<td>.07</td>
<td>.42</td>
<td>-.08</td>
<td>.19</td>
</tr>
</tbody>
</table>

*Note.* Confidence intervals and standard errors based on 1000 bootstrap samples.

In Model Two, 8% of the variance in binge drinking was explained by rash impulsiveness and mindful acceptance ($F (3, 92) = 3.28, p = .02$). Although the model contributed significant variance to binge drinking, the interaction effect was not significant ($b = .08, (3, 92) t = .904, p = .37$), indicating that mindful acceptance did not moderate the relationship between rash impulsiveness and binge drinking. Finally, in Model Three, reward sensitivity and mindful
acceptance contributed 7% variance to binge drinking, which was statistically significant ($F(3, 94) = 2.66, p = .05$). However, mindful acceptance did not significantly moderate the relationship between reward sensitivity and binge drinking, as evidenced by a non-significant interaction effect ($b = .05, (3, 94) t = .80, p = .42$). Taken together, the pattern of results indicates that although the moderation models contribute variance in binge drinking, trait-mindfulness does not significantly moderate the relationship between impulsivity and binge drinking.

**Path Analysis**

Path analysis was conducted to test the hypothesis that mindfulness will mediate the relationship between rash impulsiveness, reward sensitivity, and reflection-impulsivity. The hypothesised model is displayed together with standardised coefficients in Figure 8.2. In this model, the mindfulness variable, mindful acceptance, was used, given significant correlations were found between mindful acceptance and impulsivity variables.
Figure 8.2.

Hypothesised path analytic mediation model predicting that mindfulness will mediate the relationship between rash impulsiveness and reward sensitivity

The hypothesised mediation model revealed a significant Chi square ($\chi^2$) $(3, N = 96) = 18.68, p < .01; CFI = .74$ and RMSEA = .23). Additional fit indices are presented in Table 8.13, and together suggest that the mediation model was of poor fit to the data.
Table 8.13.

Fit Indices for the hypothesised and re-specified models

<table>
<thead>
<tr>
<th>Fit Indices</th>
<th>Hypothesised Model</th>
<th>Re-specified Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-square</td>
<td>18.677</td>
<td>1.289</td>
</tr>
<tr>
<td>Df</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>P</td>
<td>.000</td>
<td>.525</td>
</tr>
<tr>
<td>CFI</td>
<td>.742</td>
<td>1.000</td>
</tr>
<tr>
<td>TLI</td>
<td>.139</td>
<td>1.059</td>
</tr>
<tr>
<td>RMSEA</td>
<td>.235</td>
<td>.000</td>
</tr>
<tr>
<td>SRMR</td>
<td>.104</td>
<td>.029</td>
</tr>
</tbody>
</table>

Note. df = Degrees of Freedom; p = Probability; CFI = Comparative Fit Index; TLI = Tucker-Lewis Coefficient; RMSEA = Root Mean Square Residual; SRMR = Standardised Root Mean Square Residual

Given the model was of poor fit, modification of the model was warranted. Path analysis allows hypothesised models to be modified according to theoretical and empirical guidance from the statistical output to improve the model fit (Byrne, 2001). To revise the model, modification indices were examined for adding paths to the model. Based upon empirical and statistical reasoning, a correlational path was added to the error terms of boxes opened for FW and DW conditions. As displayed in Table 8.4, these variables are strongly correlated ($r = .75$, $p < .01$), as such, this correlational path was included to the modified path analytic model. Figure 8.3 displays the re-specified model with standardised path coefficients and the squared multiple correlation coefficients ($R^2$).
Figure 8.3.

Re-specified mediation model with the addition of a correlational path between reflection-impulsivity residuals

![Diagram of the re-specified mediation model]

Note. Residual error terms are represented by e1 to e3; ** = p < .01

Testing the re-specified model revealed a non-significant Chi square ($\chi^2$) (2, N = 96) = 1.30, $p$ = .525; CFI = 1.00 and RMSEA = .00). Model fit indices are illustrated in Table 8.9, and reveal the TLI has a score greater than one. However, the TLI is non-normed and thus not required to generate a score between 0 and 1 (Cangur & Ercan, 2015). Evaluation of the fit indices indicate good fit between the model and the data.

In this model, rash impulsiveness and mindful acceptance explain 6% of the variance in reflection-impulsivity in the fixed win condition, whilst reward sensitivity and mindful acceptance explain 8% of the variance in the decreasing-win condition. Path coefficients were evaluated to examine the hypothesised effects. Reward sensitivity had a significant direct effect on mindful acceptance ($\beta = -.29$, $p < .01$) and on reflection-impulsivity that approached, but did not achieve significance ($\beta = -.18$, $p = .067$). There were no significant pathways between rash impulsiveness and mindfulness ($\beta = -.08$, $p = .458$), nor reflection-
impulsivity ($\beta = -0.14, p = .151$). Mindful acceptance had a direct effect on reflection-impulsivity that approached, but did not achieve statistical significance ($\beta = .181, p = .07$). As illustrated in Table 8.14, the remaining model pathways did not achieve statistical significance.

**Table 8.14.**

*Regression Weights for Hypothesised Model*

<table>
<thead>
<tr>
<th>Paths</th>
<th>b</th>
<th>$\beta$</th>
<th>SE</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>KIMS Acceptance $\leftarrow$ Rash Impulsiveness</td>
<td>-0.164</td>
<td>-0.082</td>
<td>0.221</td>
<td>0.458</td>
</tr>
<tr>
<td>KIMS Acceptance $\leftarrow$ Reward Sensitivity</td>
<td>-0.526</td>
<td>-0.294</td>
<td>0.196</td>
<td>0.007</td>
</tr>
<tr>
<td>DW Boxes Opened $\leftarrow$ Reward Sensitivity</td>
<td>-0.212</td>
<td>-0.177</td>
<td>0.116</td>
<td>0.067</td>
</tr>
<tr>
<td>FW Boxes Opened $\leftarrow$ Rash Impulsiveness</td>
<td>-0.233</td>
<td>-0.136</td>
<td>0.162</td>
<td>0.151</td>
</tr>
<tr>
<td>FW Boxes Opened $\leftarrow$ KIMS Acceptance</td>
<td>0.155</td>
<td>0.181</td>
<td>0.086</td>
<td>0.074</td>
</tr>
<tr>
<td>DW Boxes Opened $\leftarrow$ KIMS Acceptance</td>
<td>0.113</td>
<td>0.168</td>
<td>0.069</td>
<td>0.104</td>
</tr>
</tbody>
</table>

*Note.* $b =$ unstandardized regression weight; $\beta =$ standardised regression weight; SE = Standard Error; C.R = Critical Ratio; P = Probability; KIMS = The Kentucky Inventory of Mindfulness Skills

To examine the mediating effect of mindful acceptance on the relationship between rash impulsiveness, reward sensitivity, and reflection-impulsivity, the standardised indirect effects and corresponding confidence intervals were examined. The indirect effects for the hypothesised model are displayed in Table 8.15. In this model, there were no significant indirect effects of rash impulsiveness on reflection-impulsivity through mindfulness, nor was there a significant indirect effect of reward sensitivity on reflection-impulsivity through mindfulness. This pattern of results does not support the hypothesis, as
mindfulness did not mediate the relationships between rash impulsiveness, reward sensitivity, and mindfulness.

**Table 8.15.**

*Indirect effects of mindfulness on the relationship between rash impulsivity, reward sensitivity and reflection-impulsivity*

<table>
<thead>
<tr>
<th>Paths</th>
<th>Standardised Estimated Effect</th>
<th>SE</th>
<th>95% CI Lower Bounds</th>
<th>95% CI Upper Bounds</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>RI → Mindful → FW Box</td>
<td>-.025</td>
<td>.043</td>
<td>-.076</td>
<td>.033</td>
<td>.636</td>
</tr>
<tr>
<td>RI → Mindful → DW Box</td>
<td>-.019</td>
<td>.038</td>
<td>-.085</td>
<td>.019</td>
<td>.530</td>
</tr>
<tr>
<td>RS → Mindful → FW Box</td>
<td>-.081</td>
<td>.055</td>
<td>-.174</td>
<td>-.012</td>
<td>.102</td>
</tr>
<tr>
<td>RS → Mindful → DW Box</td>
<td>-.059</td>
<td>.043</td>
<td>-.198</td>
<td>-.007</td>
<td>.172</td>
</tr>
</tbody>
</table>

*Note.* SE = Indirect Effects Standard Error; CI = Confidence Interval; P = Probability; RI = Rash Impulsiveness; Mindful = Mindful Acceptance; FW Box = Fixed-win condition, boxes opened; RS = Reward Sensitivity; DW Box = Decreasing-win condition, boxes opened.
**Discussion**

The primary aims of the present study were to evaluate the role of risk taking and mindfulness in the prediction of binge drinking. In this study, risk taking significantly predicted binge drinking, and significantly mediated the relationship between rash impulsiveness and binge drinking, providing support for the first and second hypotheses. The tendency to take risks did not however, mediate the relationship between reward sensitivity and binge drinking. In the context of impulsivity, risk taking was associated with elevations in rash impulsiveness, reward sensitivity, and reduced information sampling on the IST. Inconsistent with the hypotheses, trait-mindfulness did not significantly predict binge drinking, nor did it moderate the relationship between impulsivity and binge drinking. Further, trait-mindfulness did not significantly mediate the relationship between rash impulsiveness, reward sensitivity, and reflection-impulsivity, thus rejecting the final hypothesis. Despite this, mindful acceptance was associated with greater patterns of reflection during decision making, as well as lower levels of rash impulsiveness and reward sensitivity.

**Exploring Risk Taking in the Prediction of Binge Drinking**

This study builds upon a series of studies that have investigated the role of risk taking and mindfulness in understanding patterns of impulsivity and binge drinking (de Haan et al., 2015; Fernie et al., 2010; Romer et al., 2016). Building upon the current body of research, the present study utilised both self-report and behavioural measures of risk taking across a number of risk-taking domains to explore how the disposition to take risks may contribute to binge drinking behaviour.
In this study, risk taking significantly predicted binge drinking across both self-report and behavioural measures. Specifically, greater levels of risk taking, measured by the BART-A, and the health and safety domain of risk taking, significantly predicted higher levels of binge drinking. These findings are consistent with de Haan et al. (2015), and Fernie et al. (2010), and suggest that those with a greater disposition to take risks report higher levels of binge drinking. However, the present study builds on these findings by investigating multiple domains of risk taking in the prediction of binge drinking. The remaining risk-taking domains measured by the DSRT, namely, ethical, financial, recreational, and social, did not significantly predict binge drinking in the present sample. This indicates that risk taking is a multi-faceted construct, and that the utility of each domain to predict real-world risky behaviour may vary, relevant to the context. Furthermore, the present findings indicate that although risk taking appears to enhance the risk of binge drinking, not all domains of risk taking lead to enhanced drinking behaviour.

**Risk Taking as a Mediator**

In addition to predicting binge drinking, risk taking significantly mediated the relationship between rash impulsiveness and binge drinking. Within the mediation model, rash impulsiveness was directly related to the health and safety domain of risk taking, whilst pathways between rash impulsiveness, performance on the BART-A, and binge drinking, were not statistically significant. Despite this, the indirect effect of risk taking was significant. This pattern of results indicates that rash impulsivity may influence binge drinking through elevations in risk taking, where greater rash impulsiveness is linked to elevated risk taking, which in turn leads to greater binge drinking behaviour. This pattern of results
aligns with previous research that indicates rash impulsiveness plays an important role in risk taking behaviour.

Pathways within the mediation model partially align with findings reported in Romer et al. (2016), and Maher et al. (2015). In the mediation model, rash impulsiveness significantly predicted risk taking on the health and safety domain, but did not significantly predict performance on the BART-A, whilst reward sensitivity did not predict risk taking on either measure. Romer et al. (2016) reported that while rash impulsiveness and reward sensitivity both predicted risk taking, rash impulsiveness was uniquely related to maladaptive risk taking, including behaviours such as drink driving, substance use, and risky sexual behaviour, whilst reward sensitivity predicted both adaptive and maladaptive risk taking. Similarly, Maher et al. (2015) reported that although rash impulsiveness and reward sensitivity each predict engagement in sport-related risk taking behaviour, rash impulsivity alone predicted greater levels of risk taking once the risky sport was engaged in. Taken together with the present study findings, it appears that rash impulsiveness is highly relevant in understanding risk taking behaviour, and may lead to greater risk taking across a variety of domains. Further, it appears that the impact of rash impulsiveness exerts an effect on binge drinking through an increased disposition to take risks. It is possible that this association may be relevant in delineating casual binge drinkers from those at risk of developing problematic alcohol use.

Exploring the Protective Role of Mindfulness in Binge Drinkers

Given preliminary evidence suggests that mindfulness is a correlate of alcohol use and binge drinking (Adams et al., 2013; Mermelstein & Garske, 2015), the present finding that trait-mindfulness did not significantly predict binge
drinking was unexpected. In this study, none of the mindful domains significantly predicted binge drinking, nor alcohol use. The present findings contrast to those of Adams et al. (2013) and Karyadi and Cyders (2015b). Specifically, Adams et al. (2013) reported dispositional mindfulness predicted fewer drinks consumed per week, and fewer episodes of binge drinking in a sample of African American smokers. Further, Karyadi and Cyders (2015b) reported that trait mindfulness, specifically, acting with awareness, significantly predicted lower problematic alcohol use, alcohol use quantity, and shorter alcohol use duration. It is possible that sample characteristics and methodological differences account for study differences.

Specifically, the sample recruited by Adams et al. (2013) were significantly older than those in the present sample, and were smokers enrolled in a smoking cessation trial. Of the present study sample, only six percent reported smoking two or more times per week, whilst the vast majority (75%) reported never smoking. When compared to Karyadi and Cyders (2015b), the present sample is of older age, and on average, consumed less alcohol. It is possible that these characteristics may account for study differences.

Further, both Adams et al. (2013) and Karyadi and Cyders (2015b) utilised different measures of trait mindfulness, the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003) and the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006), respectively. Each of these measures provide an assessment of dispositional mindfulness, the MAAS provides a single mindful score, whilst the FFMQ assesses five facets of trait- mindfulness, including non-judgement, non-reactivity, acting with awareness, observing, and describing (Baer
et al., 2006). As such, it is possible that the variation in mindfulness questionnaires may account for inconsistent findings in the present study.

Consistent with the current study, Murphy and MacKillop (2012) reported that although trait mindfulness was associated with lower level of alcohol use and impulsivity, mindfulness did not significantly predict alcohol use when analysed using hierarchical regression. Given the present sample were similar to those of Murphy and MacKillop (2012) with respect to alcohol use, namely, AUDIT score, and average drinks per week, results from the present study together with Murphy and MacKillop (2012) suggests that mindfulness may not influence drinking behaviour in young casual drinkers. It is possible that the protective utility of mindfulness may be more relevant in higher level drinkers.

Given trait mindfulness did not predict binge drinking, it is unsurprising that trait-mindfulness did not moderate the relationship between reflection-impulsivity and binge drinking. At present, only one study has investigated the relationship between mindfulness and reflection-impulsivity in a sample of polysubstance users (Valls-Serrano et al., 2016). In this study, a mindfulness-based intervention led to enhanced reflection and greater accuracy of performance on the IST compared to controls, and performance on the IST was significantly more reflective, and less impulsive, following the mindful intervention. Treatment outcome measures were not evaluated in this study, thus the interaction between mindfulness, reflection-impulsivity, and substance use was not assessed. In the present study, although trait-mindfulness was associated with performance on the IST, the disposition to be mindful did not change the relationship between reflection-impulsivity and binge drinking. Together, findings from Valls-Serrano et al. (2016) with the present findings suggests that mindfulness appears to
influence patterns of decision making, where greater mindful acceptance is associated with greater information sampling and superior accuracy of performance compared to those of lower mindful acceptance, however, it remains unclear as to whether this relationship in turn influences binge drinking.

**Mindfulness and Impulsivity**

Although a number of studies have investigated the association between trait-mindfulness and a number of impulsive domains such as attention, non-planning, or motor impulsivity, and sensation seeking (Murphy & MacKillop, 2012; Peters et al., 2011), little work has examined the relationship between mindfulness and both rash-impulsivity and reward sensitivity. Results from the present study indicate that greater levels of trait-mindfulness, particularly mindful awareness and mindful acceptance, are associated with lower levels of rash impulsiveness and reward sensitivity. These findings expand upon a series of studies that report an inverse relationship with trait mindfulness and domains of impulsivity (Lyvers et al., 2013; Murphy & MacKillop, 2012; Peters et al., 2011). In these studies, measures of impulsivity predominantly include the BIS-II, the Positive and Negative Affect Scale (PANAS; Watson et al., 1988), and the UPPS-P Impulsivity Scale (Whiteside & Lynam, 2001). The present study builds on these findings by investigating the impulsive domains, rash impulsiveness and reward sensitivity using the I7 and SPSRQ, respectively, and by investigating how trait mindfulness and impulsivity may affect patterns of decision making.

Consistent with the aforementioned studies, the mindful domains, total mindfulness, mindful acceptance, and mindful awareness, were significantly and negatively related to rash impulsiveness and reward sensitivity. Interestingly, mindful acceptance, described as acceptance of the present moment without
judgement or evaluation (Baer et al., 2004; Moore & Malinowski, 2009), was associated with greater reflection, correct choices, and less inaccuracy on the IST. Whilst greater mindful observing, the ability to notice and attend to internal and external stimuli such as sounds, smells, visual elements, or emotions (Baer et al., 2004), was associated with less information sampling and greater number of errors on the IST. Although this finding was unexpected, a series of studies report mindful observing to positively correlate with measures of impulsivity (Baer et al., 2006; Baum et al., 2010; Murphy & MacKillop, 2012).

It is argued that mindful observing, as measured by the KIMS, performs differently in samples with, and without meditation experience, and may not encompass the mindful act of observing in meditation-naïve samples (Baer et al., 2006; Baum et al., 2010). It is possible that meditation-naïve subjects who endorse mindful observe items may be prone to distractibility from the external environment, given items relate to the ability to notice and attend to internal and external stimuli such as sounds, smells, visual elements, or emotions.

Although specific mindfulness domains were associated with performance on the IST and the two-factor model, overall trait mindfulness did not mediate the relationship between reflection-impulsivity and rash impulsiveness, nor reward sensitivity. These findings suggest that although mindfulness is relevant in the appraisal of information and decision-making processes, it does not appear to explain the relationship between trait impulsivity, and patterns of decision making.
**Study Strengths**

When interpreting the findings of the present study, a number of study strengths should be considered. Firstly, this study is the first to investigate risk taking and mindfulness together with the two-factor model and reflection-impulsivity, in a sample of binge drinkers. The study highlights that both risk taking and mindfulness are multifaceted, and that domains of each construct relate differently to impulsivity and binge drinking behaviour. The study findings offer new insights into how risk taking may act as a mechanism that drives binge drinking behaviour as a product of rash impulsiveness.

Further, the methods utilised is considered a particular strength of the present study. Specifically, the BART-A is a well-established behavioural measure demonstrated to predict real world risk taking behaviour (Lejuez et al., 2003), whilst the DSRT provides a unique perspective of risk taking, by assessing multiple domains of risk-taking relevant to daily life (Highhouse et al., 2016). The use of these measures is considered a strength as risk taking is evaluated across multiple modalities and perspectives. This allows the present study to gain an in-depth understanding of how risk-taking tendency relates to binge drinking behaviour.

Finally, this is the first study to investigate trait mindfulness together with rash impulsiveness, reward sensitivity, and reflection-impulsivity. The present findings offer preliminary evidence to suggest that mindful awareness and mindful acceptance each are linked to lower levels of rash impulsiveness and reward sensitivity. Further, the study findings suggest that the tendency to accept present moment experiences without judgement or evaluation are linked to decisional patterns characterised by greater reflection and performance accuracy.
The present findings offer novel insights into how trait-level mindfulness may influence patterns of decision making and regulate impulsive behaviour.

**Limitations**

Although the methods utilised in the present study are considered a particular strength, at present, there is no study that reports population data for impulsivity, risk-taking, or mindfulness variables. As such, the way in which these variables are interpreted is based upon how they relate to one another. This is a potential limitation as it is difficult to determine whether participant scores in mindfulness or impulsivity constitute “High”, “Medium” or “Low” levels of these traits. The development of standardised cut-off scores through future research would enable both researchers and clinicians to more accurately identify adaptive or maladaptive levels of these traits.

A second limitation within this study relates to the cross-sectional study design. Given the present study explored the risk and protective roles of risk taking and trait-mindfulness, respectively, in binge drinking, conclusions cannot be drawn in relation to causality. Although empirical research indicates that impulsivity is a correlate of both risk-taking and trait-mindfulness (Fernie et al., 2010; Maher et al., 2015; Murphy & MacKillop, 2012; Peters et al., 2011), temporal inferences cannot be made regarding whether one precedes, or follows the other. As such, it is recommended that longitudinal research investigate these variables over time, in order to understand how impulsivity may relate to or drive risk taking behaviour, and trait-mindfulness, and how these relationships change as a result of alcohol misuse.
Further, as discussed in the preliminary data analysis section of Study Two, the Alpha level for the health/safety domain of the DSRT was .57, indicating the consistency of items within this variable may be less reliable. As such, it is suggested that the findings of Study Two that draw upon this variable be interpreted with caution. Although the association between risk-taking, binge drinking, and impulsivity are corroborated by the self-report measure of risk taking, namely, the BART-A, follow-up studies are needed to provide support of the present findings.

Finally, the measure of trait-mindfulness utilised in the present study, namely, the KIMS, is designed to provide an assessment of naturally occurring mindfulness in samples that are meditation naïve. However, the tool does not include items that measure prior exposure to, or engagement in mindful practice. As such, it is possible that a number of participants were not naïve to mindful practice, which may have impacted upon responses to outcome measures. As such, it is recommended that future studies include a measure of mindful practice and exposure, in order to control for the effect of mindful practice.

**Study Implications and Future Directions**

The study results highlight that risk-taking plays a significant role in binge drinking behaviour in young people, and that rash impulsiveness may indirectly enhance the risk of binge drinking through the tendency to take risks. As such, the screening of these domains by health practitioners may enhance identification of young people who may be at risk. Early identification of these cohorts provides the opportunity for preventative interventions such as education about the risks related to binge drinking, as well as monitoring of drinking patterns over time. It is possible that the addition of items screening for impulsivity and risk taking
used within the current study, together with well-established tools such as the AUDIT or the Alcohol, Smoking, and Substance Involvement Screening Test (WHO, 2002), may provide important clinical information to first line healthcare providers.

Further, the study findings contribute to the literature by highlighting the important role of risk taking, particularly in relation to rash impulsiveness, in drinking behaviour. Specifically, it appears that the tendency to take risks is an important domain that plays a unique role in binge drinking behaviour. This is evidenced by the significant variance in binge drinking, uniquely explained by risk taking variables. This pattern of results has important theoretical implications, particularly in the context of the two-factor model. Specifically, a series of studies highlight the importance of proximal and distal factors that underlie alcohol and substance use, to explain how an impulsive personality acts to drive drinking behaviour (Gullo et al., 2014). For example, factors such as drinking expectations, perceived control, drinking refusal self-efficacy, and affective state (Dawe et al., 2004; Harnett et al., 2013; Kabbani & Kambouropoulos, 2013) are argued to play a proximal impact on drinking, directly influenced by more distal factors, namely, rash impulsiveness and reward sensitivity. As such, the findings of this study indicate that risk taking may be an important proximal factor in drinking behaviour that is influenced by rash impulsiveness. In light of these findings, it may be valuable for future research to include measures of risk taking together with rash impulsiveness. This may be particularly important in substance using and addiction cohorts, given these groups display heightened levels of rash impulsiveness.
Further, the preliminary findings that trait-mindfulness was associated with greater levels of reflection during decision making, and lower levels of rash impulsiveness and reward sensitivity provide important implications. Although trait-mindfulness was not predictive of binge drinking, it is possible that the cultivation of mindfulness through practice may improve impulse regulation, and impulse related difficulties. A growing body of evidence provides support for the efficacy of mindfulness based interventions in reducing impulse-related issues such as binge eating, emotion dysregulation, aggressive behaviour, and binge drinking (Deplus, Billieux, Scharff, & Philippot, 2016; Franco, Amutio, López-González, Oriol, & Martínez-Taboada, 2016; Godfrey et al., 2015; Mermelstein & Garske, 2015). Given trait-mindfulness did not predict binge drinking in this study, it is possible that trait-level mindfulness may be less protective against hazardous forms of drinking, in comparison to that cultivated through practice. As such, it may be beneficial for future research to evaluate the efficacy of mindful practice in reducing drinking behaviour and impulsivity, across a variety of mediums, such as mobile applications, mindful groups, or mindfulness-based clinical interventions.

Conclusion

The present study explored the role of risk taking and mindfulness in the prediction of binge drinking behaviour in young people. Findings from the present study suggest that risk taking is a significant predictor of binge drinking, and that rash impulsiveness may influence binge drinking via individual variation in the disposition to take risks. Although trait mindfulness did not significantly predict binge drinking in the present sample, significant negative correlations between mindfulness, rash impulsiveness, and reward sensitivity, suggest that the
disposition to attend to present moment experiences in a non-evaluative way may lower the tendency to act on impulse. Further, the study findings suggest that trait mindfulness is linked to greater reflective patterns of decision making characterised by increased appraisal of information and greater decisional accuracy. The study findings have implications for future research, and provide support for the utility of mindfulness-based prevention and treatment programs that target impulse control.
CHAPTER NINE

General Discussion

Considerable empirical research highlights that rash impulsivity and reward sensitivity are significant risk factors in the development of hazardous alcohol and substance use (Gullo et al., 2014; Harnett et al., 2013; Kabbani & Kambouropoulos, 2013); however, only a small number of studies have examined this model in the context of binge drinking (Castellanos-Ryan et al., 2011; Franken & Muris, 2006a). More recently, emerging evidence indicates that the capacity to gather and evaluate information during decision making, namely, reflection-impulsivity, may be impaired in substance using and alcohol addicted cohorts, as well as in young binge drinkers (Clark et al., 2006; Clark et al., 2009; Solowij et al., 2012; Townshend et al., 2014). Empirical studies investigating reflection-impulsivity in binge drinking cohorts provides inconsistent evidence for this pattern (Banca et al., 2015; Bø et al., 2016; Townshend et al., 2014), prompting the need for continued evaluation. Thus, the primary aim of this thesis was to gain a clearer understanding of the impulsive processes that underlie binge drinking behaviour in young people by integrating multiple theories of impulsivity.

Further, the disposition to take risks, and tendency to practice mindfulness in daily life, are each known correlates of impulsivity, and argued to play a role in the binge pattern of drinking (Fernie et al., 2013; Mermelstein & Garske, 2015; Murphy & MacKillop, 2012; Romer et al., 2016). A series of studies indicate that the tendency to take risks is linked to elevations in impulsivity (Abernathy et al., 2010; Romer et al., 2016), as well as greater frequency of binge drinking episodes.
(de Haan et al., 2015; Miller et al., 2007). In contrast, the tendency to attend to present moment experiences, known as trait-mindfulness, is linked to more adaptive forms of drinking, and a reduced tendency to act on impulse (Mermelstein & Garske, 2015; Peters et al., 2011). It was argued that in order to delineate between casual drinkers and those at risk of developing more problematic forms of alcohol misuse, there is clinical utility in exploring factors that may enhance the risk of, and protect against binge drinking. Thus, a secondary aim of this thesis was to explore the risk, and protective role of risk taking and trait-mindfulness, respectively, by examining the predictive variance of risk taking, and trait-mindfulness, in binge drinking behaviour.

Together, it was argued in this thesis that a tendency towards heightened rash impulsiveness and reward sensitivity may be associated with binge drinking behaviour in young people. Furthermore, by integrating the construct of reflection-impulsivity together with the two-factor model, this may enhance our understanding of the role of impulsivity in young binge drinkers. Further, it was argued that investigating risk taking and trait-mindfulness within the impulsivity – alcohol use relationship may enhance understanding of the interrelated factors that may underlie binge drinking. The following section will discuss the major findings of the two studies reported in this thesis, provide an integration of the overall findings, and discuss the clinical and research implications that emerged as a result of the thesis findings. Further, the limitations of this thesis will be discussed, followed by recommendations for future research, and concluding comments.
Summary of Results

Study One: Examining the Role of Rash Impulsiveness, Reward Sensitivity, and Reflection-Impulsivity in Young Binge Drinkers

Study One of the present thesis was designed to create links between a series of studies (i.e., Banca et al., 2015; Bø et al., 2016; Gullo et al., 2010a; Gullo et al., 2011; Harnett et al., 2013; Townshend et al., 2014), by evaluating the role of impulsivity in binge drinking across personality and cognitive frameworks in a large community sample. In this study, reflection-impulsivity was a significant predictor of binge drinking, and explained significantly more variance than that accounted for by the two-factor model. In contrast to predictions, both rash impulsiveness and reward sensitivity were unrelated to, and did not significantly predict binge drinking within the community sample. Domains from the two-factor model were, however, related to patterns of decision making, where elevations in rash-impulsiveness and reward sensitivity were linked to lower levels of reflection and greater impulsive patterns of responding. Further, reward sensitivity appeared to be more strongly related to decisional patterns indicative of reflection-impulsivity compared to rash impulsiveness. Despite this, reflection-impulsivity did not mediate the relationship between rash impulsivity and binge drinking.

The principal findings derived from Study One extend upon Townshend et al. (2014), Banca et al. (2015), and Bø et al. (2016), indicating that reflection-impulsivity is a significant predictor of binge drinking in low-level drinkers. Inconsistent with Gullo et al. (2010a), Gullo et al. (2011), and Harnett et al. (2013), rash impulsiveness and reward sensitivity did not significantly predict binge drinking, indicating that these domains may not carry as great an influence
in low-level drinkers compared to heavier drinkers. Finally, rash impulsiveness and reward sensitivity appear to be differentially associated with reflection-impulsivity, where reward sensitivity is more strongly related to decisional performance. However, these patterns are only apparent in higher levels of binge drinking.

A major contribution of Study One was to examine the involvement of rash impulsiveness, reward sensitivity, and reflection-impulsivity together in the one study, in binge drinking behaviour. This is the first study to integrate the two-factor model with reflection-impulsivity, and one of few that applies the two-factor model specifically to binge drinking. Through this approach, this thesis makes a number of significant contributions to the literature of impulsivity, and to the understanding of binge drinking in young people.

**Study Two: Examining Risk and Protective Factors of Binge Drinking**

Study Two was designed to examine the role of risk taking and mindfulness as risk and protective factors, respectively, in the prediction of binge drinking behaviour. Further, the study sought to investigate how these factors may relate to impulsivity, and in particular, the impulsive – alcohol misuse relationship. The pattern of results reported in Study Two indicate that risk taking was a significant predictor of binge drinking, where elevations in the tendency to take risks (e.g., gambling, riding a motorcycle without a helmet, walking alone at night in an unsafe area) was linked to higher levels of binge drinking in the community sample. This finding is consistent with a series of studies (i.e., de Haan et al., 2015; Fernie et al., 2010; Fernie et al., 2013; Miller et al., 2007), and highlights the important association between risk taking and alcohol use. Further, risk taking was a significant mediator of the relationship between rash
impulsiveness and binge drinking, indicating that rash impulsiveness may indirectly influence binge drinking through an enhanced tendency to take risks.

In contrast, the pattern of results reported in Study Two indicate that trait-mindfulness may not protect against binge drinking in young people. Inconsistent with preliminary research exploring the role of mindfulness and binge drinking (Adams et al., 2013; Mermelstein & Garske, 2015), trait mindfulness was not significantly associated with, nor predictive of binge drinking. Further, trait-mindfulness did not moderate the relationship between impulsivity and binge drinking.

Building upon a series of studies (i.e., Murphy & MacKillop, 2012; Peters et al., 2011; Valls-Serrano et al., 2016), Study Two found that the tendency to accept present moment experiences was related to greater levels of reflection during decision making, and overall trait-mindfulness was linked to lower levels of rash impulsiveness and reward sensitivity. Despite these links, trait-mindfulness did not mediate the relationship between trait-level impulsivity (rash impulsiveness and reward sensitivity) and reflection-impulsivity.

The major findings reported in Study Two contribute to the literature by highlighting the important role of risk taking in its association with binge drinking behaviour, and revealing that rash impulsiveness may indirectly influence binge drinking through elevations in the tendency to take risks. Further, this is the first study to demonstrate that trait-mindfulness is positively associated with greater reflective processes during a decision-making task. Study Two makes a significant contribution to the understanding of risk taking and mindfulness, particularly in the context of impulsivity.
Discussion of Integrated Findings

The two studies reported in this thesis contribute to an expanding body of knowledge regarding the multifaceted role of impulsivity and associated domains underlying binge drinking behaviour. Together, the overall findings of this thesis are fivefold.

First, the findings add to a growing body of literature that suggests reflection-impulsivity plays an important role in binge drinking (Banca et al., 2015; Bø et al., 2016; Townshend et al., 2014). Second, there is utility in exploring variation in decisional patterns across both task conditions of the IST, and this may be particularly relevant in understanding the decisional patterns of the reward sensitive individual. Third, it appears that rash impulsiveness and reward sensitivity each play a differential role in their association with risk taking behaviour. Fourth, risk taking is likely to play an important role within the impulsivity – alcohol use relationship. Finally, trait-mindfulness may not protect against binge drinking, however, may be more important in regulating impulsive processes. These five key findings will be discussed in detail in the following sections.

Reflection-Impulsivity and Binge Drinking

The findings of this thesis provide supportive evidence for reflection-impulsivity potentially playing a role in binge drinking behaviour in young people. Specifically, decisional inaccuracy on the IST significantly predicted greater levels of binge drinking, suggesting that the way in which young adults make decisions may impact behaviour such as binge drinking. Decision making is a complex process that can involve a conflict between potential rewarding outcomes and negative consequences (Bechara, 2003). Thus, impairments in
decisional processes may lead to behaviours such as binge drinking through a reduced capacity to reflect on all available information, particularly that relating to negative consequences such as sustaining a hangover, increased spending, or intoxicated behaviour. Given the cross-sectional nature of this study, it is unclear whether impulsive patterns of decision making may predispose young people to engage in heavier binge drinking, or whether previous binge drinking has impaired decision making through accumulated neural damage. Further investigation including experimental and longitudinal studies are required to clarify the causative nature, if any, of these relationships.

Further, findings from the present thesis indicate that the association between reflection-impulsivity and binge drinking may become stronger in higher-level binge drinkers. This was evidenced by the emergence of significant correlations between IST variables and higher levels of binge drinking, when the data was split into high- and low-binge groups. It is possible that this pattern of results may be indicative of the cumulative neurotoxic effect of repeated binge episodes, as reported in Maurage et al. (2012). However, given the generally low level of binge drinking within the study sample, the present findings may be indicative of premorbid decisional characteristics, where more impulsive decisional patterns may relate to elevated binge drinking. Given there have only been three published studies which have measured reflection-impulsivity in binge drinkers, further longitudinal work is required to understand these underlying mechanisms.

Exploring Task Conditions on the Information Sampling Task

Importantly, the pattern of results reported across both studies indicates there is scope for an in-depth evaluation of the way in which performance on the
IST is interpreted between the fixed-win and decreasing-win task conditions. One of the hallmark patterns of reflection observed across studies utilising the IST is the tendency to sample less information in the fixed-win condition of the IST (Clark et al., 2006; Clark et al., 2009; Townshend et al., 2014). As discussed in Chapter Three, the fixed-win condition places no penalty on information sampling, and as such, a subject can access all possible information by opening all boxes on the task to ensure a correct decision is made. Despite this, subjects do not typically open all boxes on the task, and thus make a decision without accessing all available information. Substance using, alcohol dependent adults, and problem gamblers each display deficits in the decision-making process by sampling significantly less information in the fixed-win condition, compared to control groups (Clark et al., 2006; Clark et al., 2009; Lawrence et al., 2009; Solowij et al., 2012). Consequently, there has been an emphasis on IST performance specifically in the fixed-win condition, whilst there is considerably less discussion of performance in the decreasing-win condition among studies utilising the IST.

In contrast to the fixed-win condition, the decreasing-win condition of the IST places a penalty on information sampling by deducting ten-points for each box opened, creating a conflict between reward and certainty (Clark et al., 2006). Thus, in order to maximise the potential reward, subjects must tolerate high uncertainty by sampling less information. To reach a point of high certainty, a subject must open more boxes, however, this would reduce the total amount of points to be won. As such, the task conditions have a significant impact on the decision-making process due to the change in reward contingency. Consequently, subjects display a tendency to change their performance between each condition,
typically sampling significantly less information in the decreasing-win condition compared to the fixed-win condition (Clark et al., 2006; Clark et al., 2009; Solowij et al., 2012; Townshend et al., 2014).

Interestingly, numerous studies have reported no difference in task performance in the decreasing-win condition between substance users and non-users (Clark et al., 2006; Clark et al., 2009; Solowij et al., 2012). However, data reported in this thesis, together with that reported in Bø et al. (2016) indicate that performance in the decreasing-win condition played a significant role in the binge pattern of drinking. Specifically, the results from the present thesis indicated that in the decreasing-win condition, significant negative correlations emerged between high-binge drinking and information sampling, p-correct, and a significant positive correlation with number of errors on the task. Further, as reported in Bø et al. (2016), participants who tolerated a lower probability of making a correct decision in the decreasing-win condition significantly predicted elevations in binge drinking. Together, this pattern of results indicates that the performance in the decreasing-win condition of the IST may provide important insights, novel to that indicated by fixed-win performance, in the decisional processes of young binge drinkers.

It is argued that performance in the decreasing-win condition of the IST may be linked to processes of reward sensitivity and risk disposition, given the risk and reward constraints of the task. Data reported across Studies One and Two of this thesis provide support for this argument. Specifically, in the decreasing-win condition, the tendency to gather less information, tolerate a lower probability of making a correct choice, perform with greater errors and fewer correct choices, were significantly linked to elevations in reward sensitivity. Importantly, this
pattern of correlations was not observed in the fixed-win condition, indicating that the reward sensitive individual exhibited greater motivation to win points in response to the task condition. This is consistent with the conceptualisation of reward sensitivity, where those with elevated reward drive are particularly sensitive to positive reinforcement, and are thus more likely to be motivated to perform under conditions of reward (Dawe et al., 2007; Kambouropoulos & Staiger, 2001). Further, the pattern of correlations between reward sensitivity and reflection-impulsivity in the decreasing-win condition became stronger in higher level drinkers when the data was split into high- and low-binge groups. This suggests that elevations in binge drinking may strengthen the relationship between reward sensitivity and impulsive decisional patterns under conditions of risk and reward.

In addition to reward sensitivity, data reported in Study Two indicate that the tendency to take risks, measured across both self-report and behavioural measures, was linked to lower levels of reflection in the decreasing-win condition. Specifically, participants who exhibited risky performance on the BART-A, and reported elevations in risk taking on the DSRT, displayed reduced information sampling, lower p-correct, less correct decisions, and more errors in the decreasing-win condition. Additionally, this pattern of results was not found between risk taking and reflection-impulsivity in the fixed-win condition, further suggesting the task condition motivated riskier decisional patterns on the IST.

Taken together, the pattern of results reported in this thesis provides novel information about the nature of reflection-impulsivity in the decreasing-win condition of the IST. Specifically, the findings indicate that decisional performance, when constrained by balancing risk and reward, may be driven by
an underlying sensitivity to reward, and elevations in the tendency to take risks. Elevations in these traits appear to be linked to decisional patterns characterised by the gathering of less information, and greater performance inaccuracy. This is particularly relevant in the context of young binge drinkers, who are likely to make decisions under similar conditions of risk and reward, namely, balancing factors such as social cohesion and having fun, with risk factors such as sustaining a hangover, feelings of regret or shame (Carrera, Caballero, & Munoz, 2012; Norman, Conner, & Stride, 2012).

Given this is the first study to highlight the relevance of IST task conditions and drinking patterns in young people, future research is needed to replicate, and build upon this discussion. Specifically, future research examining reflection-impulsivity together with reward sensitivity and risk taking across a variety of samples, such as dependent drinkers, substance users, and problem gamblers, may enhance understanding of how these domains manifest across a variety of clinical issues.

**The role of rash impulsiveness and reward sensitivity in binge drinking**

Despite the two-factor model being consistently applied to young people’s drinking, the concept of binge drinking is particularly pertinent given the risks of neurotoxicity. As such, a major aim of this thesis was to examine reward sensitivity, and rash impulsiveness specifically in the binge pattern of drinking. Inconsistent with expectations, neither reward sensitivity nor rash impulsiveness was significantly related to binge drinking. This finding is inconsistent with past research that has found elevations in reward sensitivity are significantly linked to greater frequency of binge drinking (Castellanos-Ryan et al., 2011; Franken &
Muris, 2006a). Further, there was no significant association between hazardous alcohol use, measured by the AUDIT, and domains from the two-factor model. This finding was particularly unexpected, given a multitude of studies have provided support for the predictive role of rash impulsiveness and reward sensitivity in hazardous alcohol use (Gullo et al., 2010a; Gullo et al., 2011; Harnett et al., 2013; Lyvers et al., 2012).

However, analysis of high- and low-binge drinkers reported in Study One of this thesis indicated that reward sensitivity was a significant positive correlate of binge drinking in the high-binge drinking group. This suggests that while reward sensitivity may play a minor role in lower levels of binge drinking, it may become more influential in higher-level binge drinkers. Given binge drinking is not a clinical disorder, this finding aligns with the current understanding of how reward sensitivity relates to alcohol misuse. Specifically, reward sensitivity plays an important role in lower levels of alcohol and substance use among clinical samples and hazardous substance users, where consumption is driven by factors such as social interaction, experimentation, and positive drinking expectations (Clark, Loxton, & Tobin, 2015; Kabbani & Kambouropoulos, 2013). As such, in the context of binge drinkers without issues of addiction, elevations of reward sensitivity are likely to be more apparent in higher-level binge drinking.

Importantly, despite the significant association between reward sensitivity and binge drinking among high-binge drinkers, a similar relationship was not observed between reward sensitivity and hazardous alcohol use, measured by the AUDIT, among higher level drinkers. It is possible that the differential association between binge drinking, hazardous alcohol use, and reward sensitivity may be due to variation in drinking style. Specifically, the repeated pattern of
alcohol intoxication and withdrawal typical of binge drinking is qualitatively
different to global alcohol consumption (Maurage et al., 2012). It is possible that
the way in which reward sensitivity relates to binge drinking may differ from
general alcohol consumption, particularly given binge drinking is often a socially
driven behaviour.

Taken together, results from the present thesis indicate that reward
sensitivity may be linked to elevations in binge drinking behaviour, particularly
so in higher-level binge drinkers. The lack of a significant association between
rash impulsiveness and binge drinking may be indicative of the generally lower
levels of drinking within this community sample, however, given rash
impulsiveness is typically linked to riskier forms of substance misuse (Gullo et
al., 2014), it is possible that this domain may not play a role in low-level binge
drinking.

Risk and Protective Factors of Binge Drinkers

An important finding from this thesis was that risk taking was a significant
predictor of binge drinking in the community sample. The pattern of results
reported in Study Two indicate that participants who took more risks on the
BART-A, and those who reported a higher level of risk taking across health and
safety domains reported greater binge drinking compared to participants who
were more risk averse. This finding contributes to a growing body of literature by
demonstrating elevations in the tendency to take risks may play an important role
within the interplay of impulsive and behavioural patterns involved in binge
drinking (de Haan et al., 2015; Fernie et al., 2010).
This is further supported by the finding that risk taking was a significant mediator of the relationship between rash impulsiveness and binge drinking. Specifically, the findings reported in Study Two indicate that rash impulsiveness had an indirect influence on binge drinking through an enhanced tendency to take risks. This suggests that the rash impulsive individual may be more likely to take risks, which may in turn drive greater binge drinking patterns.

Similarly, Wood et al. (2013) reported that physical forms of risk taking, such as rugby or surfing, mediated the relationship between reward sensitivity and substance use in a sample of high school students. Despite being prosocial in nature, risk taking was positively associated with substance use. Together with findings from this thesis, this suggests that although risk taking can occur across a variety of contexts, the general tendency to take risks, whether prosocial or maladaptive, appears to enhance the risk of alcohol and substance use. However, the directionality of the risk-taking – alcohol use relationship cannot be inferred from the cross-sectional nature of this research. Despite this, the pattern of results presented in this thesis together with Wood et al. (2013) indicate that risk-taking plays an important role within the impulsivity – alcohol misuse relationship.

An additional contribution of this thesis was the evaluation of risk taking patterns in relation to levels of rash impulsivity and reward sensitivity. The pattern of results reported in Study Two provide support for a growing body of research that rash impulsiveness and reward sensitivity each relate to risk taking in a unique way (Maher et al., 2015; Romer et al., 2016; Wood et al., 2013). The data reported in Study Two indicate that rash impulsiveness was more consistently and strongly associated with self-report risk taking across multiple domains. In particular, rash impulsiveness was linked to elevations in ethical,
financial, health and safety, recreational, and social domains, and was most strongly associated with total risk-taking score. This suggests that the rash impulsive individual may be more likely to take risks across a wide variety of contexts and situations.

In contrast, reward sensitivity was associated with greater risk taking across health and safety, and in particular, the ethical domain. Items that measured ethical risk taking on the DSRT included “Having an affair with a married man or woman”, or “Not returning a wallet you found that contains $200”, where the likelihood of engaging in these behaviours was rated on a 7-point Likert scale. Given the nature of these items, it appears that those who are driven by reward may be more likely to prioritise the rewarding element of a situation over the ethical consideration.

This pattern of results adds to a growing body of literature that indicates rash impulsiveness and reward sensitivity each play a differential role in risk taking behaviour. However, there is variation across studies in relation to how domains from the two-factor model relate to risky behaviour. For example, Romer et al. (2016) reports rash impulsiveness is associated with maladaptive forms of risk taking such as alcohol and drug use, drink driving, and unsafe sexual behaviour, whilst reward sensitivity was linked to risk taking more broadly across maladaptive, and adaptive forms of risk taking (e.g., entering competitions and playing sports). Further, reward sensitivity has been shown to predict engagement in risky behaviour (e.g., downhill snow sports), whilst rash impulsiveness has been linked with greater risk taking within a particular behaviour (Maher et al., 2015; Thomson & Carlson, 2014a). Finally, Wood et al. (2013) found that reward sensitivity was associated with greater engagement in physical risk taking, such as
engagement in sports, whilst rash impulsiveness was linked with lower engagement in activities with the potential for emotional risk, such as public speaking or debating. Taken together with the findings of the present thesis, it appears that rash impulsiveness may be linked to elevated forms of risky behaviour that have the potential for negative outcomes, such as injury through sport (e.g., Maher et al., 2015), or addiction through increased substance use (e.g., Dissabandara et al., 2014). Conversely, reward sensitivity appears to be associated with risky behaviour that is driven by reward (e.g., Goodwin, Browne, Rockloff, & Loxton, 2016; Thomson & Carlson, 2014a), however, has less potential for harmful consequences. Given the preliminary nature of this research, future studies are needed to enhance the understanding of these patterns.

In contrast to risk taking, findings from this thesis indicate that trait-mindfulness was not a significant predictor, or correlate of binge drinking. This finding was unexpected and contrasts with a series of studies that find trait-mindfulness is linked with lower frequency of binge drinking, and less alcohol use (Adams et al., 2013; Karyadi & Cyders, 2015a; Murphy & MacKillop, 2012). Despite this, trait-mindfulness was associated with adaptive patterns of decision making and lower levels of trait impulsivity. Specifically, the tendency to accept present moment experiences without judgement was associated with greater levels of reflection during decision making. This was evidenced by the tendency to sample more information, make decisions with a greater probability of making a correct choice (i.e., p-correct), and perform with greater accuracy on the IST. Importantly, this pattern of decision making was consistent across both the fixed-win and decreasing win conditions of the IST. This suggests that participants who
are non-evaluative and accepting may prioritise decisional accuracy over incentives such as winning points on the IST.

In addition to trait-mindfulness, a recent investigation of a mindfulness-based intervention found that a sample of polysubstance users exhibited enhancements in reflection as measured by the IST, following the completion of an eight-week mindfulness intervention (Valls-Serrano et al., 2016). Specifically, the participants who engaged in the mindful intervention displayed significant increases in the amount of information sampled, and made significantly less errors in the decreasing-win condition of the IST. Conversely, participants who completed treatment as usual displayed no significant changes in patterns of decision making. Interestingly, there was no significant change in decisional performance in the fixed-win condition across both the intervention and control groups. Given the reward contingency placed upon the decreasing-win condition, the study findings suggest that participants prioritised decisional accuracy over achieving a greater reward. Thus, it is possible that mindfulness, both at the trait level, and when cultivated, is linked to a reduction in behaviour that is associated with reward.

Findings from this thesis provide preliminary support for this argument. Specifically, the data reported in Study Two indicate that reward sensitivity was a significant predictor of mindful acceptance, where lower levels of reward sensitivity were linked to elevations in the ability to refrain from judgement and accept present moment experiences. Although trait-mindfulness did not significantly mediate the relationship between reward sensitivity and information sampling, the pattern of correlations among these variables indicate that
mindfulness plays an important role in reflective patterns of decision making, and in the tendency to be motivated by rewarding stimuli.

In addition to reward sensitivity and reflection-impulsivity, the findings reported in Study Two indicate that trait-mindfulness was significantly linked to lower levels of rash impulsiveness. In particular, mindful awareness, the tendency to purposefully focus and maintain attention on one thing at a time, was linked to a reduced tendency to act rashly, without consideration of negative consequences. Links between mindfulness and rash impulsiveness are previously reported in Staiger et al. (2014), who found a negative association between rash impulsiveness and mindfulness, following five sessions of a mindfulness based intervention. Given mindfulness has been shown to break the cycle of automatic alcohol responses, and weaken the relationship between impulsivity and alcohol related cognitions (Ostafin et al., 2013), it is possible that the tendency to direct and maintain attention through an open and accepting attitude may act to preclude impulsive behaviour through an increased capacity to control or inhibit impulsive patterns of behaviour (Stratton, 2006). Together, the pattern of results reported in this thesis indicate that trait-mindfulness may play an important role in impulse regulation, and is relevant across multiple impulsive domains and processes.

Implications of This Thesis

Clinical Implications

The findings of this thesis have a number of clinical and research implications. Although binge drinking is not a clinical disorder, empirical studies suggest that young people who binge are at elevated risk of substance abuse and disorders of addiction (Crews & Boettiger, 2009; Hermens et al., 2013). As such, the clinical implications of this thesis largely relate to preventative approaches
that identify young binge drinkers who are at risk, and provide appropriate links
to support and resources.

First, providing education to health care providers, such as general
practitioners, and mental health clinicians regarding the role of repeated binge
episodes, impulsivity, particularly impulsive decisional patterns, and risk-taking
tendencies, may improve awareness and early detection of those at risk. In
addition, providing health care professions with access to the assessment tools
utilised in this thesis, particularly the BART-A, IST, and the SR subscale of the
SPSRQ, may enable clinicians to screen for, and discuss with patients, the risks
related to impulsivity, risk taking, and binge drinking. It is possible that by
utilising these tools, and screening for impulsivity and risk taking as part of a
general health or mental health assessment may prevent those who display these
risk factors from developing more problematic forms of alcohol misuse.

Given binge drinkers are not considered a clinical population, it is possible
that a number of at-risk drinkers may not present to health care providers seeking
help with patterns of drinking. Shame, stigma, and attitudes about drinking are
identified as significant barriers to treatment seeking among treatment-naïve
adults (Schuler, Puttaiah, Mojtabai, & Crum, 2015; Wallhed Finn, Bakshi, &
Andréasson, 2014). Additionally, a lack of insight and the desire to address
drinking issues alone further prevent at risk groups from seeking treatment
(Probst, Manthey, Martinez, & Rehm, 2015). As such, there is a significant
proportion of people who experience alcohol related problems who are not
receiving, or seeking appropriate treatment or support (Cohen, Feinn, Arias, &
Kranzler, 2007).
Consequently, it is possible that social media platforms may provide an opportunity to engage young binge drinkers in a way that enhances education and reduces the stigma of seeking help for drinking. An example of such a program is ‘Hello Sunday Morning’ (HSM), an Australian social media health promotion movement that engages young binge drinkers who may be at risk of more problematic forms of drinking.

The social movement encourages people to engage in a period of abstinence and blog about their experiences in a supportive online community (Carah, Meurk, & Hall, 2015). HSM is unique as it combines elements of health promotion, and encourages abstinence through the construction of adaptive goals such as enhancing fitness, saving money, improving relationships, as well as goals relating to alcohol use (Carah et al., 2015). Thus, participants are supported in developing a prosocial identity that is not dependent on alcohol use.

Since its inception in 2009, HSM has engaged over 7000 participants across the world, the majority of which reside in Australia. Importantly, the majority of Australian participants are young adults aged between 20 and 49 years, who engage in risky or highly risky drinking, as measured by the AUDIT (Carah et al., 2015). Evaluation of the program among Victorian participants ($n = 49$), indicated that upon joining HSM, a majority of participants reported high-risk levels of drinking, which dropped to low-risk, one-month post joining HSM (Pennay, Rankin, & MacLean, 2015). At three months follow up, the rate of drinking gradually increased to risky levels, however, drinking was still reduced compared to the initial assessment. Further, participants reported a number of benefits from engaging in HSM, including improved physical health and mental
health, greater productivity, financial savings, and engagement in new activities (Pennay et al., 2015).

The HSM movement provides a good example of the far-reaching capacity of online social communities to engage young Australians who are unlikely to seek treatment for alcohol-related issues. The prosocial and health focussed nature of the program may act to bypass stigma relating to treatment seeking, and increase an individuals’ awareness of the impact alcohol misuse may have on their daily lives. Movements such as these may benefit from including additional screening tools that assess the risk factors identified in this thesis, such as risk-taking tendency, and impulsive decisional patterns. Given the online platform, behavioural assessments such as those used in the present thesis (i.e., the IST and the BART-A) may provide a viable, and engaging measure of these known risk factors, and be used to direct goal setting. Additionally, providing young audiences with information about how impulsivity and risk taking may underlie and perpetuate alcohol misuse may increase insight, and enhance opportunities to prevent binge drinking from developing into alcohol abuse.

**Research Implications**

In addition to the clinical implications, the findings from this thesis prompt a number of research implications. First, the finding that high-binge drinkers exhibited less reflection in the decreasing-win condition of the IST, and that performance within the decreasing-win condition was significantly related to reward sensitivity and risk taking, indicate that there is scope for continued examination of decision making patterns within the decreasing-win condition of the IST. Specifically, the thesis findings highlight an opportunity for an in-depth evaluation of decisional patterns within the decreasing-win condition, particularly
in the context of reward sensitivity and risk-taking behaviour. Given previous studies have predominantly focused on decisional performance within the fixed-win condition of the IST (Clark et al., 2006; Clark et al., 2009; Townshend et al., 2014), performance within the decreasing-win condition has not necessarily been operationalised or defined. The study findings indicate that decisional performance in the decreasing-win condition appears to be influenced by a motivation to win points, and risky decisions are made at the expense of performance accuracy. As such, it may be valuable for future research to conduct an in-depth evaluation of performance on the IST within the decreasing-win condition together with constructs such as impulsivity and reward sensitivity in order to clearly understand and define what this task specifically measures, and what this means within the broader context of alcohol use.

Second, findings from this thesis provide preliminary support for the utility of the continued evaluation of impulsivity across multiple domains and modalities within the context of alcohol and substance misuse. Despite a series of studies indicating a trend for self-report and behavioural measures of impulsivity to generally obtain low correlations with one another (Cyders & Coskunpinar, 2011; Sharma, Markon, & Clark, 2014), investigation across modalities are warranted to enhance the understanding of how impulsivity may predict drinking behaviour (Gullo et al., 2014). Findings from this thesis provide support for this argument. Specifically, although the two-factor model did not contribute significant variance toward the prediction of binge drinking, each domain of impulsivity was related to binge drinking. For example, elevations in reward sensitivity were significantly linked with higher binge drinking within the high-binge drinking group, whilst rash impulsiveness was indirectly related to binge
drinking through risk taking tendency. Further, lower levels of reflection were linked to elevations in binge drinking, and this relationship became stronger among high-level binge drinkers. Given the present sample reported relatively low levels of drinking, future research may wish to examine these variables in samples of heavier drinkers, substance users, and clinical samples such as those suffering addiction and substance use disorders.

Further, the present thesis adopted both self-report and behavioural measures of risk taking within this study, as there appears to be an overlap between measures, and the conceptualisation of risk taking and impulsivity in previous research (Nigg, 2017). Although these domains are closely related, this thesis argued that risk taking and impulsivity are distinct but related constructs. This was supported by the weak to moderate correlations between impulsivity and risk taking, and the finding that risk taking uniquely predicted binge drinking, over and above that of trait impulsivity. Further, this finding highlighted the importance of risk taking in influencing patterns of drinking in young people. Thus, it is recommended that future researchers utilise well validated measures of risk taking, such as those used in the present thesis, in order to further understand how the tendency to take risks may underlie problematic forms of substance use.

Finally, a series of studies report an inverse relationship exists between trait-mindfulness and impulsivity (Murphy & MacKillop, 2012; Peters et al., 2011), which was supported by the present thesis. The findings reported in this thesis contribute to the field by indicating trait-mindfulness is linked to greater reflection during decision making, where mindful acceptance was linked to greater sampling of information and performance accuracy. Given the association between trait-mindfulness and decisional performance was similar across both the
fixed-win and decreasing-win conditions of the IST, this suggests that elevations in mindfulness may help regulate impulsive patterns of behaviour, particularly those driven by an enhanced sensitivity to reward. However, further research is needed in order to replicate this finding, and to explore the link between mindfulness and reward sensitivity. It may be valuable for researchers to examine these relationships within heavier drinkers or substance users, in order to investigate the extent to which mindfulness may protect against elevations in impulsivity following substance misuse.

Limitations and Future Directions

Although the findings reported in this thesis provide novel insights into the nature of binge drinking and impulsivity, limitations associated with the research should be considered. First, the cross-sectional nature of this research enables the investigation of relationships among variables of interest; however, causality cannot be inferred. Future research may consider conducting longitudinal research that evaluates binge drinking over time in the context of impulsivity and risk taking, in order to gain insight into the temporal associations that may exist among these variables. Given prospective research indicates that impulsivity may precipitate alcohol and substance misuse (George et al., 2010; Stautz & Cooper, 2013), it is possible that in addition to trait impulsivity, impulsive patterns of decision making indicative of reflection-impulsivity may also carry influence over the development of the binge pattern of drinking. Moreover, empirical studies suggest that the binge pattern of drinking leads to impairments in executive functioning (Maurage et al., 2012; Maurage et al., 2009) which may have implications for elevations in impulsivity and the development of impaired decisional patterns. Indeed, studies that report impairments in reflection-
impulsivity in binge drinkers and substance users attribute these findings to damage sustained to the prefrontal regions (Lawrence et al., 2009; Solowij et al., 2012; Townshend et al., 2014), however, this has not specifically been tested in studies of reflection-impulsivity. As such future research examining patterns of reflection-impulsivity together with functioning of the executive system, particularly longitudinal research designs, may provide important information on how patterns of reflection may relate to executive functions.

The primary aim of this thesis was to investigate patterns of impulsivity specifically in binge drinking in a community sample. Studies evaluating impulsivity in alcohol and substance misuse have predominantly focused on clinical forms of addictive behaviour and hazardous levels of alcohol misuse (Dissabandara et al., 2014; Gullo et al., 2010b; Harnett et al., 2013). Fewer studies have focused on sub-clinical forms of alcohol consumption, and in particular, binge drinking in the general population. Particularly in the context of the two-factor model, there has been far less investigation on whether rash impulsiveness and reward sensitivity may apply to the prediction of casual binge drinkers, hence the present thesis investigation. As such, the findings reported in this thesis provide novel insights into how the two-factor model, and reflection-impulsivity relate to patterns of binge drinking within a non-clinical population, and can be generalised within the broader community.

However, given the low levels of substance use within this sample, the ability to generalise the thesis findings to substance misusers or clinical populations is limited. Importantly, the role of rash impulsiveness and reward sensitivity in substance misuse is well established in the clinical literature (Gullo et al., 2014). While a series of studies indicate that reflection-impulsivity is
impaired in substance users (Clark et al., 2006; Clark et al., 2009; Solowij et al., 2012), there are fewer empirical studies exploring reflection-impulsivity in this field. Given the findings from this thesis indicate that patterns of decision making are related to domains in the two-factor model, future research is warranted to investigate the two-factor model together with reflection-impulsivity within clinical samples and substance users in order to investigate how these frameworks may interrelate and underlie substance use.

Finally, the use of self-report measures of alcohol use presents as a limitation due to issues related to self-report biases and underreporting. Specifically, the ability of self-report measures to provide a valid measure of alcohol use can be influenced by participants underreporting their alcohol use. This is particularly relevant in measures of alcohol use, as factors such as social desirability may lead participants to underreport their drinking (Dawe, 2002). In addition, the self-report measures of alcohol use utilised in this thesis required participants to report on their drinking habits retrospectively. The accuracy of these measures may be impacted by inaccuracy in memory. This may be particularly relevant in binge drinkers, as increased intoxication is likely to lead to greater memory inaccuracy (Wilson, Allen, National Institute on Alcohol, & Alcoholism, 2003). Further, alcohol consumption is a complex behaviour that can vary considerably over time (Wilson et al., 2003). Factors such as the time of year may impact upon the way participants drink, and thus complete measures of alcohol use. For example, recruitment of participants for the present thesis occurred over a period of nine months, which incorporated the holiday season. It is possible that for those who participated around the holiday season, the drinking patterns reported may have been less reflective of normal drinking patterns.
Conclusion

This thesis was the first to integrate the impulsive dimensions, rash impulsiveness and reward sensitivity, together with reflection-impulsivity in the prediction of binge drinking. The findings indicate that reflection-impulsivity was a significant predictor of binge drinking behaviour, where impulsive patterns of decision making characterised by performance inaccuracy were linked to elevations in binge drinking. However, the relationship between rash impulsiveness and reward sensitivity was more complex. It appears that while rash impulsiveness may exert an influence on binge drinking through an enhanced tendency to take risks, reward sensitivity appears to relate to binge drinking only through heavier binge patterns.

Further, the present thesis contributed to the current field of impulsivity by exploring decisional patterns within the context of the two-factor model. Importantly, the findings from this thesis highlighted the importance of evaluating decision making performance across both task conditions of the IST, and indicated that performance on the decreasing-win condition may provide important information about decisional patterns driven by reward sensitivity and risk taking. Recommendations were made regarding future exploration of reflection-impulsivity, and in particular, to operationalise IST performance within the decreasing-win condition.

In addition, this thesis explored the risk and protective role of risk taking and trait-mindfulness, respectively, in the prediction of binge drinking. The findings indicated that risk taking across self-report and behavioural measures, was a significant predictor of binge drinking, where elevations in the tendency to take risks was linked to greater binge drinking. The present thesis did not find an
association between trait-mindfulness and binge drinking, suggesting that the tendency to attend to present moment experiences in a non-evaluative way may not protect against patterns of binge drinking. However, trait-mindfulness appears to be important in regulating impulsive behaviour. Specifically, the findings reported in this thesis indicate that trait-mindfulness is linked with lower levels of rash impulsiveness and reward sensitivity, as well greater levels of reflection during decision making.

Taken together, the findings of this thesis provide novel insights into the literature of impulsivity and binge drinking. However, it should be noted that the present findings are preliminary in nature, and it is recommended that future research both replicate and expand upon this research within a broader context. In particular, it is recommended that future research explore these frameworks within clinical contexts such as those experiencing issues of addiction and substance misuse.
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Appendix A: Participant Demographic Information

1. Age: _____

2. Sex:  M  F

3. Please indicate which applies to you at the present time:
   - Full-time employment
   - Part-time employment
   - Casual employment
   - Unemployed

4. Occupation: _____________________

5. Please indicate the highest education level you have achieved
   - Primary school
   - Some high school
   - High school certificate
   - Undergraduate degree
   - Honours degree
   - Postgraduate degree
   - Other – please specify: _____________________

6. If you are currently studying, please indicate your course:
   _____________________

7. What age did you have your first drink that contained alcohol?
   ______

8. What age did you start drinking on a regular basis? ______

9. On average how often would you take the following drugs?
<table>
<thead>
<tr>
<th>Substance</th>
<th>Never or less</th>
<th>Monthly</th>
<th>2-4 times a month</th>
<th>2-3 times a week</th>
<th>4 or more times a week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobacco</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Ecstasy (MDMA)</td>
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<tr>
<td>Cannabis</td>
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<tr>
<td>Methamphetamines (speed)</td>
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<tr>
<td>Cocaine</td>
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<td>GHB</td>
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<tr>
<td>LSD</td>
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<tr>
<td>Magic Mushrooms</td>
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</tr>
<tr>
<td>Benzodiazepines (benzos, anti-anxiety medication)</td>
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<tr>
<td>Opiates (heroin, morphine)</td>
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<tr>
<td>Inhalants (glue, paint thinner)</td>
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</tbody>
</table>
Appendix B: The Automatic Balloon Analogue Risk-Taking Task

Instructions

Page 1:

Now you're going to see 64 balloons, one after another, on the screen.

Each balloon will be pumped up and will eventually pop when it reaches its explosion point. Some of these balloons might pop after just one pump. Others might not pop until they fill the whole screen.

For each balloon, you will be asked how many times you want to pump up the balloon.

You get money for every pump. Each pump earns $0.05. However, if a balloon pops before it can be pumped up as many times as you indicated, you lose the money you earned on that balloon.

After each time you collect $$$ or pop a balloon, a new balloon will appear.

At the end of the experiment, you will be not be paid the amount earned on the game.

Click your mouse button for a summary."

Page 2:

* You write the number of times you want to pump up each balloon in a provided textbox.

* Remember: each balloon can be pumped up 128 times (but if it had not popped after 127 times, it will surely pop after 128)
* Each balloon is then pumped up until a) that number is reached or b) it pops. Whatever occurs first.

* If it does not explode, you make $0.05 for each pump.

* If it does explode, you will not make any money on this balloon.

* The ideal number of pumps is 64. However, the best overall strategy may not be the best strategy for any one balloon.

* There are just 64 balloons.

* At the end, you will not be paid the amount you earned on the game.

Now, do you have any questions?

Click your mouse button to start"
Appendix C: The Domain Specific Risk-Taking Questionnaire

Instructions: For each of the following statements, please indicate the likelihood that you would engage in the described activity or behaviour if you were to find yourself in that situation. Provide a rating from Extremely Unlikely to Extremely Likely, using the following scale:

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<td>Extremely Unlikely</td>
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1. Admitting that your tastes are different from those of a friend
2. Going camping in the wilderness
3. Betting a day’s income at the horse races
4. Investing 10% of your annual income in a moderate growth mutual fund
5. Drinking heavily at a social function
6. Taking some questionable deductions on your income tax return
7. Disagreeing with an authority figure on a major issue
8. Betting a day’s income at a high-stake poker game
9. Having an affair with a married man/woman
10. Passing off somebody else’s work as your own
11. Going down a ski run that is beyond your ability
12. Investing 5% of your annual income in a very speculative stock
13. Going white-water rafting at high water in the spring
14. Betting a day’s income on the outcome of a sporting event
15. Engaging in unprotected sex
16. Revealing a friend’s secret to someone else
17. Driving a car without wearing a seat belt
18. Investing 10% of your annual income in a new business venture

19. Taking a skydiving class

20. Riding a motorcycle without a helmet

21. Choosing a career that you truly enjoy over a more secure one

22. Speaking your mind about an unpopular issue in a meeting at work

23. Sunbathing without sunscreen

24. Bungee jumping off a tall bridge

25. Piloting a small plane

26. Walking home alone at night in an unsafe area of town

27. Moving to a city far away from your extended family

28. Starting a new career in your mid-thirties

29. Leaving your young children alone at home while running an errand

30. Not returning a wallet you found that contains $200
Appendix D: The Information Sampling Task Verbal Instructions

Fixed-win condition

“You are about to play a game in which you can win points. The game will take about twelve minutes to complete. It consists of a short practice part and then two main parts. On each main part there will be 10 turns. On every turn, you will be able to see 25 boxes on the screen.”

“To start with, all the boxes will be grey, like the are at the moment. When you touch a box, it opens and shows one of two colours. You have to decide whether there are more blue boxes, or more yellow boxes, and then touch the panel of that colour at the bottom of the screen. If you make a correct decision, you win 100 points, and if you make a wrong decision, you lose 100 points. You will start with 100 points. Try to win as many more points as you can.”

“Try touching one of the boxes now. And another box. Touch some more boxes until you are ready to decide, and then touch one of the panels at the bottom of the screen.”

“That was the practice part – well done.”

“Not we’ll try playing for some more points. It will be just the same as the practice part, and there will be different colours on every turn. Again, you will start will 100 points, and you have to decide whether there are more (colour 1) boxes, or more (colour 2) boxes. You will win 100 points if you choose the correct colour, regardless of how many boxes you open, and you can open as many boxes as you wish. You will lose 100 points if you get it wrong. Try to win as many points as you can.”
“Well done, that’s the end of that part”.

**Decreasing-win condition**

“Now we’ll try playing for some more points. The way you win points this time is slightly different. Again, you’ll start with 100 points. However, on each of these turns, the amount you can win starts at 250 points and will go down by 10 points with every box you open, so the earlier you make your decision, the more points you will win, if you get it right. You will lose 100 points if you get it wrong, regardless of when you make your decision. Try to win as many points as you can.”

“Well done, that’s the end of the test”.

Appendix E: The Sensitivity to Reward subscale of the Sensitivity to Punishment, Sensitivity to Reward Questionnaire Short-Form

Instructions: Please answer each question by selecting ‘YES’ or ‘NO’ for the following questions. There are no right answers, and no trick questions. Work quickly and do not think too long about the exact meaning of the question.

1. Does the prospect of obtaining money motivate you strongly to do some things? Yes  No

2. Do you often do things to be praised? Yes  No

3. Do you like being the centre of attention at a party or a social meeting? Yes  No

4. Do you spend a lot of time on obtaining a good image? Yes  No

5. When you are in a group, do you try to make your opinions the most intelligent or funniest? Yes  No

6. Do you often take the opportunity to pick up people you find attractive? Yes  No

7. As a child, did you do a lot of things to get peoples approval? Yes  No

8. Does the possibility of social advancement motivate you to action, even if this involves not playing fair? Yes  No
9. Do you generally give preference to those activities that imply an immediate gain?  
   Yes  No

10. Do you often have trouble resisting the temptation of doing forbidden things?  
    Yes  No

11. Do you like to compete and do everything you can win?  
    Yes  No

12. Do you sometimes do things for quick gains?  
    Yes  No

13. Does your attention easily stray from your work in the presence of an attractive stranger?  
    Yes  No

14. Are you interested in money to the point of being able to do risky jobs?  
    Yes  No

15. Do you like to be competitive in all of your activities?  
    Yes  No

16. Would you like to be a socially powerful person?  
    Yes  No

17. Do you like displaying your physical abilities even though this may involve danger?  
    Yes  No
Appendix F: The Eysenck Impulsiveness Scale

Instructions: Please answer each question by selecting ‘YES’ or ‘NO’ for the following questions. There are no right answers, and no trick questions. Work quickly and do not think too long about the exact meaning of the question.

1. Do you often buy things on impulse?  
   Yes  No

2. Do you generally do and say things without stopping to think?  
   Yes  No

3. Do you often get into a jam because you do things without thinking?  
   Yes  No

4. Are you an impulsive person?  
   Yes  No

5. Do you usually think carefully before doing anything?  
   Yes  No

6. Do you often do things on the spur of the moment?  
   Yes  No

7. Do you mostly speak before thinking things out?  
   Yes  No

8. Do you often get involved in things you later wish you could get out of?  
   Yes  No

9. Do you get so ‘carried away’ by new and excited ideas, that you never think of possible snags?  
   Yes  No

10. Do you need to use a lot of self-control to keep out of trouble?  
    Yes  No
11. Would you agree that almost everything enjoyable is illegal or immoral?  
Yes  No

12. Are you often surprised at people’s reactions to what you do or say?  
Yes  No

13. Do you think an evening out is more successful if it is unplanned or arranged at the last moment?  
Yes  No

14. Do you usually work quickly, without bothering to check?  
Yes  No

15. Do you often change your interests?  
Yes  No

16. Before making up your mind, do you consider all the advantages and disadvantages?  
Yes  No

17. Do you prefer to ‘sleep on it’ before making decisions?  
Yes  No

18. When people shout at you, do you shout back?  
Yes  No

19. Do you usually make up your mind quickly?  
Yes  No
Appendix G: The Alcohol Use Questionnaire

Instructions: The following questions ask you about your habitual use of various types of alcoholic drinks. Please consider your drinking for the last six months in answering the questions and take your time to give an accurate answer to each question.

1. On how many days per week do you drink wine, or any wine type product (e.g., sherry, port, martini (at least one small glass))? _______
   o Please state your usual brand(s): ______________________

2. On those days you do drink wine (or similar), about how many glasses (pub measure) do you drink? _______
   o If you are unsure, please estimate the number of bottles or parts of a bottle: _____________________

3. How many glasses (pub measure) of wine do you have in a week, in total? _______

4. On how many days per week do you drink beer or cider (at least half a pint)? _______
   o Please state the usual brand (e.g., Carlsberg Special, White Lightening, etc.): ______________________

5. On those days you do drink beer/cider, about how many pints do you typically have? _______

6. How many pints of beer/cider do you drink in a week, in total? _______

7. On how many days per week do you drink spirits (whisky, vodka, gin, rum, etc., but not beer or wine)? _______
8. On those days you do drink spirits, about how many shots (pub measure) do you typically have? ______

9. How many drinks or spirits do you have in a week, in total? ______

10. When you drink, how fast do you drink? (Here, a drink is a glass of wine, a pint of beer, or a shot of spirits, straight or mixed)

   o 1 drink every 3 or more hours
   o 1 drink every 2 hours
   o 1 drink per hour
   o 3 drinks per hour
   o 4 drinks per hour
   o 5 drinks per hour
   o 6 drinks per hour
   o 7+ drinks per hour

11. How many times have you been drunk* in the last 6 months? ______

   *By ‘drunk’ we mean loss of co-ordination, nausea and/or inability to speak clearly

12. What percentage of the times that you drink do you get drunk? ______
Appendix H: The Alcohol Use Disorders Identification Test

Instructions: Try to answer the following questions in terms of ‘standard drinks’. Please ask for clarification if required. Please select the response that best fits your drinking.

1. How often do you have a drink containing alcohol?
   - Never
   - Monthly or less
   - 2-4 times a month
   - 2-3 times a week
   - 4 or more times a week

2. How many standard drinks containing alcohol do you have on a typical day when you are drinking?
   - N/A
   - 1 or 2
   - 3 or 4
   - 5 or 6
   - 7 to 9
   - 10 or more

3. How often do you have six or more standard drinks on one occasion?
   - Never
   - Less than monthly
   - Monthly
   - Weekly
   - Daily or almost daily

4. How often during the last year have you found that you were not able to stop drinking once you had started?
   - Never
   - Less than monthly
5. How often during the last year have you failed to do what was normally expected of you because of your drinking?
   - Never
   - Less than monthly
   - Monthly
   - Weekly
   - Daily or almost daily

6. How often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking session?
   - Never
   - Less than monthly
   - Monthly
   - Weekly
   - Daily or almost daily

7. How often during the last year have you had feelings of guilt or remorse after drinking?
   - Never
   - Less than monthly
   - Monthly
   - Weekly
   - Daily or almost daily

8. How often during the last year have you been unable to remember what happened the night before because of your drinking?
   - Never
   - Less than monthly
   - Monthly
   - Weekly
9. Have you or someone else been injured as a result of your drinking?
   - No
   - Yes, but not in the last year
   - Yes, during the past year

10. Has a relative or friend or a doctor or other health worker, been concerned about your drinking or suggested you cut down?
   - No
   - Yes, but not in the last year
   - Yes, during the past year
Appendix I: The Kentucky Inventory of Mindfulness Skills

Instructions: Please rate each of the following statements using the scale provided. Select the response option that best describes your own opinion of what is generally true for you.

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<td>Never or very rarely true</td>
<td>Rarely true</td>
<td>Sometimes true</td>
<td>Often true</td>
<td>Very often or always true</td>
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1. I notice changes in my body, such as whether my breathing slows down or speeds up
2. I’m good at finding the words to describe my feelings
3. When I do things, my mind wanders off and I’m easily distracted
4. I criticize myself for having irrational or inappropriate emotions
5. I pay attention to whether my muscles are tense or relaxed
6. I can easily put my beliefs, opinions, and expectations into words
7. When I’m doing something, I’m only focused on what I’m doing, nothing else
8. I tend to evaluate whether my perceptions are right or wrong
9. When I’m walking, I deliberately notice the sensations of my body moving
10. I’m good at thinking of words to express my perceptions, such as how things taste, smell, or sound
11. I drive on “automatic pilot” without paying attention to what I’m doing
12. I tell myself that I shouldn’t be feeling the way I’m feeling
13. When I take a shower or bath, I stay alert to the sensations of water on my body
14. It’s hard for me to find the words to describe what I’m thinking
15. When I’m reading, I focus all my attention on what I’m reading
16. I believe some of my thoughts are abnormal or bad and I shouldn’t think that way
17. I notice how foods and drinks affect my thoughts, bodily sensations, and emotions
18. I have trouble thinking of the right words to express how I feel about things
19. When I do things, I get totally wrapped up in them and don’t think about anything else
20. I make judgments about whether my thoughts are good or bad
21. I pay attention to sensations, such as the wind in my hair or sun on my face.
22. When I have a sensation in my body, it’s difficult for me to describe it because I can’t find the right words
23. I don’t pay attention to what I’m doing because I’m daydreaming, worrying, or otherwise distracted
24. I tend to make judgments about how worthwhile or worthless my experiences are
25. I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing
26. Even when I’m feeling terribly upset, I can find a way to put it into words
27. When I’m doing chores, such as cleaning or laundry, I tend to daydream or think of other things

28. I tell myself that I shouldn’t be thinking the way I’m thinking

29. I notice the smells and aromas of things

30. I intentionally stay aware of my feelings

31. I tend to do several things at once rather than focusing on one thing at a time

32. I think some of my emotions are bad or inappropriate and I shouldn’t feel them

33. I notice visual elements in art or nature, such as colours, shapes, textures, or patterns of light and shadow

34. My natural tendency is to put my experiences into words

35. When I’m working on something, part of my mind is occupied with other topics, such as what I’ll be doing later, or things I’d rather be doing

36. I disapprove of myself when I have irrational ideas

37. I pay attention to how my emotions affect my thoughts and behaviour

38. I get completely absorbed in what I’m doing, so that all my attention is focused on it

39. I notice when my moods begin to change
# Plain Language Statement

## TO: Participant

### Plain Language Statement

**Date:**

**Full Project Title:** Reflection-Impulsivity: A Cognitive Perspective on Binge Drinking

**Principal Researcher:** Dr Nicolas Kambouropoulos

**Student Researcher:** Thea Bridgman

**Associate Researcher(s):**

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### Purpose and Background

This letter invites you to participate in a research project that will examine the relationship between binge drinking patterns, impulsiveness, mindfulness, and risk taking, among young adults. If you are aged between 18 to 35 years, you are invited to participate in the study, whether you agree to participate is completely up to you. The project aims to examine how individual differences in personality traits relate to the cognitive processes behind decision making, and how these processes relate to patterns of risk taking and binge drinking. Researchers aim to recruit at least 100 people into the project. The project is being conducted by researchers at Deakin University and will form part of a Doctor of Psychology research thesis.

### Funding

This research is funded by Deakin University.

### Procedures

If you agree to participate, you will be asked to provide information in the form of a survey, a short interview, and the completion of two computer tasks. Participation will take no more than 1 hour and 10 minutes to complete. Survey items will include information about your background (e.g., age, education),
information about risk taking, impulsiveness, mindfulness, and alcohol use. Examples of questions that will be asked include rating the extent to which the following statements are true “I tend to do several things at once rather than focusing on one thing at a time” and “Do you often do things on the spur of the moment?”

You will not be paid for your participation in this project. However, if you complete the project you will have the chance to win up to $10 during completion of the computer tasks.

Possible Benefits
There are no direct benefits for your participation in this project. However, participating in this research may contribute to knowledge about personality and cognitive factors that influence patterns of binge drinking.

Possible Risks
There are no anticipated risks for participating in this project. However, given the questionnaire will include questions regarding issues such as alcohol use and risk taking, there is a possibility that you may experience some concern about your responses. If you find yourself feeling sad or distressed at any point, you are encouraged to contact Lifeline on 131 114. In addition, you can also contact Dr Nicolas Kambouropoulos on (03) 9244 6596. You will have the opportunity to discuss your concerns in a confidential manner and appropriate follow up will be suggested if necessary.

Participation is Voluntary
Participation in any research project is voluntary. If you do not wish to take part you are not obligated to. Your decision whether to take part or not, or to take part and then withdraw, will not affect your relationship with Deakin University in any way.

Once you have read this information and agreed to participate, please sign the consent form below, and return the consent form to the researcher. If you decide to take part and change your mind, you may withdraw up until you have completed the study, simply inform the researcher that you wish to withdraw. Please note that you can only withdraw up until you have completed the study, after you have completed the study we will not be able to identify your responses to your name, so will not be able to withdraw your responses.

Privacy, Confidentiality and Disclosure of Information
Due to the anonymous nature of this study, you will be given a code number to maintain your confidentiality. This will be used to match responses from the questionnaire with the computer tasks and interview data to ensure they are grouped together. The code number will be kept separately from your personal details and there will be no way to match the code to any of your identifying information. Therefore, the researchers will not be able to identify you from your
code number. Storage of data will adhere to the University regulations and kept in secure storage for six years following publication, after which the data will be disposed of in a confidential manner. Electronic information will be stored in password-protected files on a computer, and hard copies will be stored in a locked filing cabinet at Deakin University which will only be accessible by the Principal and student researchers. You can be assured that you will not be identified by name in any way in the reporting of our results in the research thesis, publications, and conference presentations.

**Results of the Project**

A summary of the findings will be provided to the School of Psychology, Deakin University and will be available for any interested participants to read at the completion of the study. Please contact Thea Bridgman at tbridgm@deakin.edu.au if you would like to receive a copy of this report.

**Complaints**

If you have any complaints about any aspect of the project, the way it is being conducted or any questions about your rights as a research participant, then you may contact:

The Manager, Research Integrity, Deakin University, 221 Burwood Highway, Burwood Victoria 3125, Telephone: 9251 7129, research-ethics@deakin.edu.au

Please quote project number: [HEAG-H 132_2014]

**Further Information, Queries or Any Problems**

For further information concerning this project, or if you have any problems which may be related to your involvement in the project, you can contact the principle researcher Dr Nicolas Kambouropoulos at the School of Psychology, Deakin University, 221 Burwood Highway, Burwood, Victoria, 3125, on (03) 9244 6596 or email nicolas.kambouropoulos@deakin.edu.au.

The researcher responsible for this project is:

Thea Bridgman
School of Psychology
Deakin University
221 Burwood Highway
Burwood, 3125
Email: tbridgm@deakin.edu.au
Appendix K: Consent Form

CONSENT FORM

TO: Participant

Date:

Full Project Title: Reflection-Impulsivity: A Cognitive Perspective on Binge Drinking

Reference Number: 2014-275

I have read, or have had read to me, and I understand the attached Plain Language Statement.

I freely agree to participate in this project according to the conditions in the Plain Language Statement.

I have been given a copy of the Plain Language Statement and Consent Form to keep.

The researcher has agreed not to reveal my identity and personal details, including where information about this project is published, or presented in any public form.

Participant’s Name (printed) ……………………………………………………………

Signature ……………………………………… Date ……………………………

Thea Bridgman  
School of Psychology  
Deakin University  
221 Burwood Highway  
Burwood, 3125  
Email: tbridgm@deakin.edu.au