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Exploring the Interaction of Executive Functioning and Reward Sensitivity across College Students who vary by Family History of Alcohol Misuse

by

Catherine Lorraine Williams

A dissertation

submitted in partial fulfillment

of the requirements for the degree of

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To the Graduate Faculty:

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RE: Study number IRB-FY2016-10: Executive Functioning, Reward Sensitivity, and Family History on Alcohol Use and Drinking Consequences

Dr. Williams:

You are granted permission to continue your study as described effective immediately. The study is next subject to continuing review on or before Aug 16, 2017, unless closed before that date.

As with the initial approval, changes to the study must be promptly reported and approved. Contact Tom Bailey (208-282-2179, humsubj@isu.edu) if you have any questions or require further information.

Sincerely,

Ralph Baergen, PhD, MPH, CIP

Human Subjects Chair

Dedication

This dissertation is dedicated to my loving husband, Brandon: a giant among men, and on whose shoulders I have graciously been allowed to stand. It is also dedicated to my parents, who have helped me touch all the towers of my life.

Table of Contents

Abstract

Both children and adults with a family history of alcohol use disorder (AUD) are at a greater risk of heavy alcohol use and alcohol-related problems than individuals without a family history of AUD. Previous studies have shown that adults with a family history of AUD tend to perform worse on certain executive tasks and have a greater sensitivity to rewarding cues. Importantly, recent research has also suggested that greater reward sensitivity and poorer executive functioning interact to predict more alcohol consumption and drinking consequences than either feature alone, but this interaction has not been compared across individuals with and without a history of parental alcohol misuse. This study's goals were to evaluate the interaction between certain aspects of executive functioning – specifically, behavioral inhibition, updating, and set-shifting – and reward sensitivity while predicting alcohol use and drinking consequences at a 6 month follow-up in a sample of college students. This interaction was evaluated across two groups of students: those with and without a history of parental alcohol misuse. Data analysis was conducted using multiple group comparisons within structural equation modeling. Results indicated initial model misspecifications, including poor overall fit for a single latent factor of executive functioning. After adjustments to the measurement model yielded an excellent fit to the data, a structural model was specified that demonstrated a significant influence of age, executive functioning, and gender on maladaptive alcohol use. A two-way interaction was found between the executive functioning and reward sensitivity factors within the positive family history group only. The results indicate that a duel-process model of addiction may be inappropriate for evaluating executive functioning and reward sensitivity in college students.

CHAPTER ONE: INTRODUCTION

Unsafe alcohol use is a major health hazard that has significant economic and health consequences, contributing to hospitalizations, criminal activity, lost earnings, traffic accidents, and premature death (NIAAA, 2015). It can adversely impact individuals, families, and community members (Popovici & French, 2013) physically, emotionally, and financially. College students' unsafe heavy drinking may lead to significant adverse consequences (Christiansen, Vik, & Jarchow, 2002; Wechsler et al., 2002; Wechsler & Nelson, 2008) and can predict alcohol use disorders as far as 10 years in the future (O'Neill, Parra, & Sher, 2001). Therefore, understanding the risk and protective factors for problematic student drinking promises benefits to both the drinker and those close to him or her.

Two factors that have recently been shown to be related to problematic drinking in college students are executive functioning and reward sensitivity (Jonker et al., 2014; Patrick, Blair, & Maggs, 2008). Executive functioning is a broad construct that refers to the general integration of cognitive processes to support sustained, goal-oriented behavior (Miyake et al., 2000). There may be up to 33 different ways to define and categorize executive functioning processes (Sergeant, Geurts, & Oosterlaan, 2002), including planning, attention management, self-monitoring, and self-awareness (Loring, 1999). Of the variety of processes that constitute executive functions, inhibition, set-shifting, and updating are three well-studied cognitive processes that predict distinct aspects of cognitive control and behavior (Miyake et al., 2000). Furthermore, these three abilities

appear to be implicated in alcohol abuse (Houben & Wiers, 2009; Patrick, Blair, & Maggs, 2008; Trick et al., 2014).

Poorer executive functioning abilities (Polderman et al., 2006), greater reward sensitivity (Andrews et al., 2011), and a higher incidence of alcohol use disorders (AUDs; Heath et al., 1997; Whitfield et al., 2004) are more prevalent among individuals with a positive family history of alcohol problems. This has been demonstrated repeatedly in community samples, which have shown that children of parents with an AUD (or even children with a first-degree relative who has an AUD; Park & Schepp, 2014) are more likely than children of non-AUD parents to develop a substance use disorder. A recent meta-analysis demonstrated generally consistent patterns in college student samples as well, noting that a positive family history of alcohol problems put undergraduate university students at a greater risk for drinking consequences than students without such history (Elliott, Carey, & Bonafide, 2012).

Reward sensitivity is a construct that emerged out of the work of Gray and colleagues (e.g., Gray, 1970; 1982; Gray & McNaughton, 2000) on approach and avoidance behaviors. Individuals who are more sensitive to reward tend to be more extraverted, willing to try new things, and likely to indulge in pleasurable behaviors than individuals who are low in the dimension of reward sensitivity. A recent review of the reward sensitivity and psychopathology literature suggested that individuals who are more sensitive to reward also tend to consume more alcohol, are more reactive to drinking cues, and engage in more hazardous drinking patterns (Bijttebier, Beck, Claes, & Vandereycken, 2009).

As individuals who are more sensitive to reward have greater approach behaviors to alcohol, those with both high levels of reward sensitivity and poor executive functioning abilities may be the most likely to engage in risky drinking and have severe drinking consequences. This idea has been described as a dual process model of alcohol addiction (Wiers & Stacy, 2006). However, it is unclear how tenable this theory is in a nonclinical population, so recent research has attempted to answer this question. Jonker and colleagues (2014), van Hemel-Ruiter and colleagues (2015), and Patrick, Blair, and Maggs (2008) have each demonstrated that low executive functioning and high reward sensitivity interact to predict a greater amount of alcohol consumption, primarily through mechanisms of attentional control in samples of students. That is, students with high reward sensitivity are more likely to attend to alcohol cues, but especially so if their inhibitory and sustained attentional abilities are poor. This, in turn, leads to greater alcohol consumption.

There are several limitations to these studies, however. The first is that many of the executive functioning processes that could be implicated in alcohol consumption and problems were not examined, such as set-shifting, planning, or concept formation. Furthermore, one of the processes that was examined, attentional control, is a nonspecific process required for many other aspects of executive functioning; that is, some executive abilities (e.g., behavioral inhibition) require sustained attention in addition to other coordinated processes, so assessing attentional control does not inform researchers about many specific cognitive abilities that may be more robustly related to reward sensitivity and alcohol use.

Second, the primary outcome of two of these three studies was amount of alcohol consumption, not problematic alcohol use patterns or drinking consequences. While quantity of alcohol consumption is related to alcohol problems and facets of alcohol use disorder (Dawson, Grant, & Hartford, 1995), the pattern of alcohol consumption (i.e., binge drinking on the weekends versus light drinking throughout the week) is also very important when predicting drinking consequences in college students (Wechsler et al., 2002; Wechsler & Nelson, 2008). Drinking consequences may be better than other assessment measures (e.g., symptoms of AUD) at characterizing the distinctive ways in which problematic alcohol use manifests in student populations (Christiansen et al., 2002), so including problems within a model of maladaptive alcohol use may allow for finer distinctions of risk in students.

One final question that remains to be answered is whether or not the interaction between executive functioning and reward sensitivity is a vulnerability that is especially pronounced in students with a positive family history of alcohol problems. Certain lines of research suggest that individuals with a positive family history of AUDs have genetic vulnerabilities for poorer executive functioning and reward sensitivity, leading to dysregulated drinking and alcohol problems (Andrews et al., 2011; Gierski et al., 2013). Other studies have supported the importance of an individual's early learning environment by demonstrating that both the amount of modeling and the degree of closeness to the family member with the AUD mediate the relationship between family history and drinking outcomes for the individual (Brown et al., 1999). Both hypotheses underscore the importance of understanding multifaceted risks for problematic alcohol use in individuals who are already at risk due to their family history. Thus, this study

proposes to investigate whether students with a positive family history of alcohol problems would demonstrate a stronger interaction between executive functioning deficits and heightened reward sensitivity than students without a family history of alcohol problems.

CHAPTER TWO: LITERATURE REVIEW

Executive Functioning, Alcohol Use, and Alcohol-Related Problems

In some of its earliest definitions, executive functioning was considered a unitary ability or trait that managed short-term memory for a variety of purposeful activities. Baddeley's (1986) "central executive," as it was called, managed language-based and visual-spatial information for goal-oriented action; it was a unitary ability that, if damaged, would result in global deficits in many aspects of executive functioning: planning, inhibition, and initiation, among others.

However, clinical observation and research into individual differences suggested that this conceptualization of executive functioning was likely inaccurate (Miyaki et al., 2000). Executive functioning has historically been measured with neuropsychological instruments such as the Wisconsin Card Sort Task, the Go-No Go Task, and the Tower of Hanoi, and experiments that have assessed executive functioning with a battery of these instruments have occasionally found surprisingly low correlations between these tests, even among tasks purportedly assessing the same construct. Miyaki and colleagues (2000) clarified that although executive functioning processes may be related via some nonspecific cognitive abilities (e.g., attention), there are distinct differences in the abilities known as information updating and monitoring ("updating), mental set-shifting ("shifting"), and inhibition of prepotent responses, both motor and non-motor ("inhibition").

Information updating refers to the "updating and monitoring of working memory representations" (Miyaki et al., 2000, p. 56). Updating tasks require an individual to monitor information in their working memory while simultaneously screening new information to determine if it is relevant to a task at hand; if it is, this new information is incorporated into memory while any old, irrelevant information is permitted to be forgotten. Functional neuroimaging has demonstrated that successful performance on both verbal and nonverbal updating tasks rely heavily on coordinated activity in the dorsolateral prefrontal cortex and lateral parietal regions of the brain (Gray, Chabris, & Braver, 2003). Updating has typically been measured with complex working memory tests such as the *N*-back task or operation span (O-Span).

Mental shifting refers to the ability to switch between multiple tasks, mental sets, or operations. One of its most important components is attentional control (Stemme, Deco, & Busch, 2007) as tasks that measure shifting require an individual to alternate from a task or rule that is no longer relevant to a task or rule that is relevant. However, it may also measure the ability to engage a new task despite proactive interference or negative priming from the first task (Miyaki et al., 2000). Functional neuroimaging and translational (i.e., animal) research have suggested that mental shifting does not rely on the activity of a single area of the brain. For example, the ventromedial and antero-dorsal areas of the prefrontal cortex appear to be differentially involved in reversing stimulus-response associations and shifting rules (Dalley, Cardinal, & Robbins, 2004; Nagahama et al., 2001).

Inhibition in its most general sense refers to the intentional suppression of a prepotent, relatively automatic response. However, the term inhibition may actually refer

to as many as eight distinct psychological processes (Nigg, 2000). For example, inhibition may refer to either cognitive or behavioral control of an automatic response; conceptualized another way, inhibition could refer to an "early" (i.e., a conscious decision not to begin an action process, like in the No Go task) versus a "late" inhibitory act (i.e., a final decision to stop motor output that was already initiated, like the Stopping task; Filevich, Kuhn, & Haggard, 2012). With training, inhibition of a response may be relatively automatic (Nigg, 2000; Spierer, Chavan, & Manuel, 2013), although most novel inhibitory tasks are effortful. Inhibition can be further distinguished by the source of the inhibitory signal: that is, whether or not the individual processes an external inhibitory cue or whether inhibition is initiated from within the individual. This latter type of inhibitory signal is notorious problematic to study outside of neuroimaging as there is no easy way to determine if an individual's self-directed inaction is due to late inhibition of a prepared response or if the individual never decided to act from the outset (Filevich, Kuhn, & Haggard, 2012). Neuroimaging studies have suggested that these inhibitory differences are related to differences in neural activity, too. For example, the dorsal fronto median cortex (dFMC) is more active during internally-motivated inhibition than externally-motivated inhibition, whereas the medial prefrontal cortex and left inferior parietal/middle temporal cortex demonstrate more activity during proactive (i.e., "early") inhibitory control of motor responses (Filevich, Kuhn, & Haggard, 2012). In contrast to motor responses, the anterior cingulate cortex may be more active during thought suppression, and the dFMC may be more active during inhibition of emotion. Despite the differences in neurological underpinnings across types of inhibition, both "late" inhibition (i.e., the Stopping Task) and "early" inhibition (i.e., the Go/No-Go Task)

have demonstrated impairments in individuals with alcohol use disorder (Noël et al., 2007) and social drinkers who scored high on trait temptation to drink (Muraven & Shmueli, 2006).

The relationship between executive functioning and alcohol consumption is complex: at least bidirectional, and best answered with longitudinal studies. For example, there are several studies that have examined the impact of alcohol and substance abuse *on* executive functioning in the developing brains of adolescents and young adults (e.g., Hanson et al., 2011; see Montgomery et al., 2012, for a review). Research has generally supported deficits during alcohol abuse or early recovery from alcohol abuse, with the potential for greater recovery over time. However, there is also a robust history of research into what makes children of alcoholics more predisposed to develop alcoholism than children of non-alcoholic parents, with executive functioning as one posited vulnerability. Children of alcoholics have demonstrated significant differences on tasks assessing inhibition and memory, for example (Nigg et al., 2004; 2006; Peterson, Finn, & Pihl, 1992). Executive functioning deficits in children of alcoholics are particularly interesting because they appear to be a more theoretically consistent mechanism that might explain behavior frequently seen in addicted individuals (e.g., affect and behavioral dysregulation; Nigg et al., 2006). A developmental model in which an inherited diathesis interacts with stress, parental modeling, substance use, and other environmental factors to result in increased alcohol use may best explain the significant executive functioning differences seen between adults with and without alcohol problems (Iacono, Malone, & McGue, 2008; Tarter et al., 1999).

Across all categories of executive functioning, behavioral inhibition has received the most support for predicting problematic substance use and addictive qualities. For example, results of one longitudinal study that spanned 40 years revealed that behavioral inhibition (assessed via self-report) measured at age 8 and again at age 19 predicted frequency of alcohol consumption as well as problematic alcohol use at ages 30 and 48 for both men and women (Dubow, Boxer, & Huesmann, 2008). In contrast, socioeconomic status, negative relationships with parents, popularity in school, and IQ assessed at 8 and 19 did not predict subsequent alcohol use or problems. After controlling for age and parents' diagnosis of alcoholism, clinician ratings of behavioral inhibition of children between the ages of 3 and 5 subsequently predicted age of onset of alcohol use, incidence of drunkenness, and illicit drug use during early adolescence, such that children with lower rated behavioral inhibition consumed alcohol earlier and were more likely to report onset of drunkenness and other illicit drug use in adolescence (Wong et al., 2006). The results of another analysis that used the same database as Wong et al. (2006) found that children's performance on a measure of behavioral inhibition, the Stopping Task, at ages 12 through 17 was significantly related to drinking consequences and number of illicit drugs used after controlling for IQ, set-shifting ability (i.e., Wisconsin Cart Sorting Task performance), and the presence of conduct disorder (Nigg et al., 2006). Results from this study also determined that poorer response inhibition when the child was 15- to 17-years-old predicted more alcohol-related problems (e.g., drinking and driving) as a young adult (Wong et al., 2010).

Research into behavioral inhibition has not always yielded consistent results, however. For example, despite substantial evidence that poor behavioral inhibition in

childhood and adolescence predicts problematic substance use outcomes, Goudriaan, Grekin, and Sher (2011) did not find that performance on the StopSignal inhibition task in second year college students predicted heavy episodic drinking or greater frequency of alcohol consumption when students were in their fourth year of college. Although the authors did not provide possible explanations as to why their results were inconsistent with other studies, certain developmental factors typical of college student drinking patterns might be one possibility. That is, evolution of relationship status (i.e., single, married, or in a committed relationship), self-efficacy in social situations, and religious influences may have played a role in the reduction of college student drinking patterns as students aged (Vik, Cellucci, and Ivers, 2003).

Research into the predictive power of updating for alcohol related problems has not been as extensive as research on behavioral inhibition. Weiland and colleagues (2012) analyzed data from the Michigan Longitudinal Study and found evidence that high trait resiliency in adolescence correlated with better working memory abilities as measured by the n-back task; high resiliency and working memory capacity predicted later onset of drinking, fewer alcohol problems, and less illicit drug use. However, Ellingson and colleagues (2014) assessed both working memory capacity (i.e., digit span task) and functional working memory (i.e., updating via the "keep track task," which is similar to the n-back task) in college students, and they found that only working memory capacity interacted with social deviance to predict current and prospective alcohol involvement, such that individuals poor in working memory capacity and high in social deviance had more drinking consequences.

In another large college student sample, Gunn and Finn (2013) found that trait impulsivity assessed via self-report personality and impulsivity measures (i.e., Eysenck Impulsivity Questionnaire) partially mediated the relationship between working memory and alcohol-related problems. In Gunn and Finn's study, working memory was assessed via the Operation-Word Span test (OWS; Conway and Engle, 1994) and a modified version of the Auditory Consonant Trigram test (ACT; Brown, 1958). These complex span tasks assess both working memory capacity and abilities related to mental manipulation, attentional control, and maintenance of memory traces over time. Based on the mixed results in these three studies, limited conclusions can be drawn. Although it appears that certain aspects of working memory (e.g., capacity; Ellingson et al., 2014) appear to be related to drinking consequences, other aspects are less conclusive (e.g., overall performance on the n-back test). It may be that attention, which has been implicated in deviance and alcohol-related problems, is more closely related to working memory capacity than performance on a working memory task, as performance may require attentional control in combination with other abilities (e.g., arithmetic).

Finally, even fewer studies have evaluated the predictive power of set-shifting on alcohol-related problems. A few studies have found that deficits in set-shifting predict problematic alcohol consequences only when evaluating subsets of alcohol problems. For example, Giancola and colleagues (1996) used the Wisconsin Card Sorting Test (WCST) to predict the following five categories of drinking consequences: physical, intrapersonal, interpersonal, social responsibility, and impulse control. The authors assessed the performance of male, social drinking college students and found that poorer performance on the WCST was related to more impulse control consequences, but not

consequences in any of the other domains. However, studies such as the one published by Parada and colleagues (2012) did not find evidence for a relationship between set-shifting and alcohol-related problems. These authors found that college students with a history of binge drinking performed worse on tasks of auditory working memory (i.e., backward Digit Span task) and planning (i.e., Self-Ordered Pointing Test), but not set-shifting (i.e., WCST) or generativity (i.e., Verbal Fluency). The inconsistency of set-shifting tasks will be explored more in the context of reward sensitivity in the section below.

Reward Sensitivity, Executive Functioning, and Alcohol Use

Responsiveness to substance-related cues is known as reward sensitivity (Bijttebier et al., 2009). Individuals who are more sensitive to reward tend to enjoy novelty and sensation-seeking, and they also tend to have more alcohol-related problems (Tapper et al., 2015). Consistent with this characterization, a recent meta-analysis found that one of the greatest personality traits to predict alcohol consumption and problematic alcohol use in adolescents was sensation-seeking (Stautz & Cooper, 2013), although traits like poor perseverance and planning were also significant predictors of these outcomes.

Although reward sensitivity has been implicated in addictive disorders, its role in the development of substance misuse in nonclinical populations is unclear. A prominent model of addiction suggests that addictive tendencies arise due to dysregulated activity in automatic "approach" or appetitive behaviors, which result in an increased sensitivity to and an attentional bias toward rewarding objects and cues of reward (Kreusch, Vilenne,

& Quertemont, 2013; Wiers et al., 2007). However, the relationship between attention deficits and alcohol may be far more complicated than a unidirectional explanation, as nondependent drinkers who have a history of heavy social drinking display poorer inhibition to alcohol-related cues after consuming alcohol (Roberts, Miller, Weafer, & Fillmore, 2014); that is, the consumption of alcohol may increase reward sensitivity and make attentional predispositions worse or even create previously nonexistent reward biases in certain drinkers.

Reward sensitivity's relationship with alcohol misuse is further complicated by its interaction with executive functions. Several different executive functions appear to play a "braking" mechanism to contrast reward sensitivity's approach tendencies, as is outlined in a dual process model of addiction (e.g., Wiers & Stacy, 2006). For example, Houben and Wiers (2009) found that college students with poorer inhibition tended to have stronger associations between positive, implicit alcohol associations and drinking problems; implicit associations are thought to be one "pure" way to estimate reward sensitivity because they closely reflect subconscious attentional biases. Peeters and colleagues (2012; 2013) have found similar results in adolescents using a different measurement of reward sensitivity. In these studies, adolescents that demonstrated greater behavioral approach to alcohol cues via a "pull" on the Alcohol Approach-Avoidance Task tended to have more alcohol use if they performed poorly on an inhibitory task, but not if their response inhibition was also strong.

Despite the fact that the majority of studies on executive functioning and reward sensitivity have focused on inhibition, a subset of studies have evaluated how other aspects of executive functioning may interact with reward sensitivity to contribute to

alcohol-related problems. The theoretical mechanisms behind each of these relationships vary. For example, Jonker and colleagues (2014) examined the relationship between reward sensitivity, punishment sensitivity, and "executive control" when predicting amount of alcohol consumption in college undergraduates. "Executive control," specifically, was an attention task that measured increases in reaction time when participants were asked to press a button that was inconsistent with a prior signaling cue; therefore, it may be more accurate to state that these researchers were evaluating attentional control. This was a curious choice of study given that attentional control is a nonspecific ability thought to underlie all executive functioning abilities (Miyake et al., 2000). Even more interesting is that these researchers did not find a relationship between reward sensitivity and attentional control in college students, although van Hemel-Ruiter and colleagues (2015), who conducted a nearly identical study that employed the same measures of executive functioning, found a significant relationship between attentional control and reward sensitivity in early adolescence. That is, adolescents with weak attentional control and high reward sensitivity consumed greater quantities of alcohol than adolescents with weak attentional control or high reward sensitivity alone. These findings are intriguing and suggest that the differences between the findings of Jonker et al. (2014) and van Hemel-Ruiter et al. (2015) may be due to developmental differences consistent with the age of the respective subjects. Executive functioning is thought to develop rapidly in adolescence, coinciding with the development of the prefrontal cortex and the lateral temporal lobes of the brain, which are also thought to be the last structures to fully develop in humans (Gogtay et al., 2004). In contrast, motivational subsystems of the brain (e.g., the striatum) develop sooner than the prefrontal and regulatory subsystems

(Casey & Jones, 2010), which may help to explain why adolescents with greater reward sensitivity and poorer self-regulation are at a heightened risk for alcohol-related consequences than adults.

A few studies have evaluated the interaction between reward sensitivity and updating ability. For example, Patrick, Blair, and Maggs (2008) used the *n*-back task as an estimate of working memory and updating ability in female college students, and they used a gambling task and a self-report measure (the BIS/BAS scales; Carver & White, 1994) to estimate reward sensitivity in two different ways. Although there was no main effect of updating ability when predicting alcohol or drug use, both reward sensitivity measures were significantly, positively related to alcohol and drug use. Curiously, the researchers also found that higher performance on the *n*-back task interacted with greater self-reported approach sensitivity to predict more alcohol use, drug use, and delinquency.

Several other studies have evaluated how reward sensitivity interacts with working memory capacity. Although capacity and updating performance are not equivalent things, the two are closely related aspects of working memory (Miyake et al., 2000), and as such these studies have implications for updating. One such study found that individuals with high working memory capacity and more *explicit* positive associations for alcohol (i.e., more positive, self-reported alcohol expectancies) tended to have greater alcohol use at a one-month follow up; in contrast, individuals with low working memory capacity and more *implicit* positive associations for alcohol (i.e., via an implicit association task) tended to have greater alcohol use at a one-month follow up (Thrush et al., 2008). Thrush and colleagues argued that alcohol expectancies required "deep processing" to impact decision-making but did not explain what "deep processing"

was. In contrast, Patrick, Blair, and Maggs (2008) reasoned that college students with high working memory capacity may be able to pursue goal-oriented behaviors (i.e., the pleasurable effects of alcohol or drinking situations) while avoiding negative consequences better than students with poor working memory capacity. In support of this idea, both studies found that the working memory/reward sensitivity interaction only predicted amount of alcohol consumption but not problematic drinking consequences.

Interactions between reward sensitivity and set-shifting ability have been previously documented in college students, suggesting that students who have greater sensitivity to reward are able to shift sets more quickly than less sensitive individuals (Avila et al., 2003). Shifting abilities rely heavily on coordinated activity between the prefrontal cortex and the limbic system; for example, impairment in the nucleus accumbens (a structure implicated in the anticipation of reward) inhibits shifting ability (Floresco, Ghods-Sharifi, Vexelman, & Magyar, 2006). Because shifting abilities are influenced greatly by the ability to discern the changing rules of rewarding behavior (i.e., to determine when one response ceases to be correct), it seems plausible that individuals who are more sensitive to reward and who have more efficiently connected frontostriatal anatomy would be better at performing set-shifting tasks. However, because sensitivity to reward is also related to more alcohol consumption and alcohol-related problems (Tapper et al., 2015), it is also possible that individuals who are better at goal-oriented set-shifting could have more alcohol use and fewer alcohol-related problems. Extant research has evaluated the influence of acute alcohol intoxication on set-shifting, with results suggesting mild-to-moderate intoxication yielding impairment (Guillot et al., 2010). However, research linking set-shifting abilities and later alcohol use is scarce

(Day, Kahler, Ahern, & Clark, 2015), and an interaction between set-shifting and reward sensitivity has yet to be evaluated to predict alcohol use or alcohol-related problems specifically. Thus, this study will serve as the first exploration of this interaction. Contrary to predictions for other executive functions like inhibition, *better* set-shifting ability should interact with greater reward sensitivity to predict more alcohol consumption but fewer alcohol-related problems.

The Risk of Having a Family History of Alcohol Problems

Problematic alcohol use may be defined in many different ways. One of the most common standards for identifying an individual's problematic alcohol use is through the diagnostic assessment of an alcohol use disorder. The diagnostic and statistical manual of mental disorders, fifth edition (DSM-5) defines an alcohol use disorder as "a pathological pattern of behaviors related to use of the substance… within overall groupings of *impaired control, social impairment, risky use,* and *pharmacological criteria*" (italics within original text; APA, 2013, pp. 483). The utility of such a definition is that it helps distinguish more innocuous forms of alcohol consumption from unhealthy or socially harmful drinking.

However, the diagnostic symptoms of alcohol use disorder do not capture all aspects of problematic alcohol use. Furthermore, not all problematic drinking may meet criteria for an alcohol use disorder, particularly for adolescents and young adults who may not have yet had time to develop a physiological dependence on alcohol. For these reasons, many researchers choose to evaluate a range problematic outcomes for young

drinkers, typically highlighting those that occur in social and educational contexts rather than clinical ones (Christiansen et al., 2002; Wechsler et al., 2002).

Even so, alcohol use disorders have historically been well-funded and well-researched due to their clinical significance. As such, there is a wealth of research to suggest the influence of family and heritability in alcohol use disorders (AUDs), ranging from twin studies (e.g., Heath et al., 1997; Whitfield et al., 2004) to studies of biological children of alcoholics (COAs; e.g., Jester et al., 2015; Leonard et al., 2000). Research has even suggested that executive functioning deficits implicated in AUDs may be heritable (Gierski et al., 2013), although attempts to identify specific genes that underscore executive functioning deficits have yielded mixed results (Barnes et al., 2011; Benzerouk et al., 2013; Gullo et al., 2014).

That children with a family history of alcohol use disorder are more likely to perform poorly on tasks of executive functioning is already well established. For example, Ozkaragoz, Satz, and Noble (1997) reported that 10- to 14-year-old boys with a family history of AUDs had greater impairment on attentional tasks than did sons of social drinkers. Corral and colleagues (1999) elaborated on these findings by identifying how high familial density of AUDs (i.e., ≥3 relatives are positive for an AUD) significantly predicted poorer performance on a visuospatial task (i.e., Block Design) and a working memory task (i.e., Digit Span). Furthermore, there were no significant differences between children with no family history of AUD and children with a low familial density of AUDs (i.e., only one parent has an AUD). This pattern of results was consistent at a 3-year follow-up (Corral et al., 2003). One longitudinal study that has tracked a group of children from ages 3-5 through late adolescence has consistently found

evidence of executive functioning vulnerability in children with a positive family history of AUDs (Nigg et al., 2004; 2006; Wong et al., 2010), with additional evidence that early executive functioning impairments may lead to alcohol and substance abuse later in adolescence (Nigg et al., 2006; Wong et al., 2010).

There are additional studies that suggest that the risks incurred by having a positive family history of AUDs extend beyond adolescence and into adulthood. Indeed, the same pattern of aberrant connectivity in frontostriatal pathways of the brain (i.e., areas involved in the processing and pursuit of reward) that has been documented in young children with a positive family history of AUD has also been noted in adult children of alcoholics (Heitzeg et al., 2010; Li et al., 2009). However, the vulnerabilities incurred by family history may exist independent from adult alcohol consumption, as Gierski and colleagues (2013) reported that adults (ages 18-59) with a family history of alcohol use disorder performed worse on tasks of set-shifting (e.g., WCST) and inhibition (e.g., Trail Making Test and Stroop) than individuals who had no family history after controlling for any other psychiatric diagnoses, nicotine consumption, and IQ; within this particular sample, there were no significant differences across groups in measures of past alcohol consumption and symptoms of alcohol dependence, ruling out the possible confound of adult alcohol consumption (Gierski et al., 2013).

Adult children of alcoholics appear to have atypical processing and expression of reward sensitivity. For example, Andrews and colleagues (2011) used neuroimaging techniques to demonstrate that adult children of alcoholics had blunted activity in their ventral striatum when anticipating a monetary reward, which is similar to the aberrant response of a detoxified alcoholic (Wrase et al., 2007). However, Yarosh and colleagues

(2014) examined differences in reward sensitivity as assessed by an fMRI gambling task and self-report questionnaires across two groups of adults who either had a positive family history or a negative family history of AUDs, and their results were less conclusive. There were no significant differences in neural activation in response to rewards, and the two groups of adults did not differ by how much they bluffed (i.e., a measure of reward-related risk taking) throughout the game. However, there were differences in self-reported "compulsivity" and reward sensitivity, as assessed by the Behavioral Inhibition System/Behavioral Activation System (BIS/BAS) scale, the Barratt Impulsivity Scale, the Sensitivity to Punishment/Sensitivity to Reward Questionnaire, and the Sensation-Seeking Scale. Andrews et al. (2011) also documented how the aberrant neural activity observed in their study was related to self-reported impulsivity, which may be connected via impaired executive functioning.

Given these mixed results and the potential contributions of reward sensitivity and executive functioning to risky decisions and behaviors, there is a clear need for additional research on the relationship between the two constructs. Furthermore, research should focus on populations at risk of heavy drinking. Although past research on drinking outcomes has primarily defined family risk as having a parent with an alcohol use disorder, it may be that parents' problematic alcohol use in absence of a formal diagnosis conveys similar risks to offspring. Therefore, this study intends to focus on the differences between college students who do and do not endorse a family history of problematic alcohol consumption. These students will be characterized as having a positive parental history (PHP) or a negative parental history (PHN) of problematic alcohol use.

The Proposed Study

This study proposes to examine the interactions between executive functioning and reward sensitivity across college students with or without a positive parental history of problematic alcohol use. Specific interactions between inhibition and reward sensitivity, set-shifting and reward sensitivity, and updating and reward sensitivity will be used to predict amount of alcohol consumption, pattern of alcohol consumption, and alcohol-related consequences, which will be measured both concurrently with other variables and again at a 6-month follow-up.

Consistent with previous research on behavioral inhibition (e.g., Nigg et al., 2006; Wong et al., 2010), while also expanding upon the scope of previous investigations, performance in all three executive functioning domains is hypothesized to be poorer among students with a family history of alcohol-related problems. Furthermore, impairments across all executive functioning tasks are expected to result in more alcohol consumption, more hazardous alcohol consumption (i.e., binge drinking), and more alcohol-related problems. Consistent with prior research (e.g., Andrews et al., 2011), self-reported reward sensitivity is also expected to be greater among students with a family history of alcohol problems. Greater reward sensitivity is also expected to predict more alcohol consumption, more problematic alcohol consumption, and more alcohol-related problems.

Given the previously documented interactions between reward sensitivity and inhibition (Houben & Wiers, 2009), shifting (Avila et al., 2003), and updating (Patrick,

Blair, & Maggs, 2008), the following outcomes are expected. College students who perform worse on updating and inhibition tasks (but better on set-shifting tasks) and have greater levels of reward sensitivity will be more likely to consume more alcohol, have more hazardous alcohol use, and have more alcohol-related problems. Furthermore, these interactions are expected to be most prominent among individuals who have a family history of problematic alcohol use. These hypotheses are important to investigate because they may shed light on the cognitive vulnerabilities for a group at risk of alcohol problems or an alcohol use disorder. A unique strength of this investigation is that it also proposes to assess the predictive ability of such vulnerabilities by recording future consumption of alcohol and alcohol-related problems. Including these variables in this study adds incremental validity to the argument that this study is indeed evaluating a vulnerability to subsequent alcohol misuse.

Summary and Hypotheses

Alcohol abuse in college students is a significant problem, and students that engage in risky and problematic drinking in college have a greater likelihood of developing substance use disorders later in life. There are many factors that predict problematic drinking in college students; two are executive functioning and reward sensitivity. Both variables have been independently linked to substance abuse in adolescence and adulthood (Nigg et al., 2004; 2006; Stautz & Cooper, 2013; Tapper et al., 2015; Wong et al., 2010), and they have also been shown to interact to predict

substance use and related problems (Houben & Wiers, 2009; Patrick, Blair, & Maggs, 2008; Peeters et al., 2012; van Hemel-Ruiter et al., 2015).

Research on children of alcoholics (Heitzeg et al., 2010; Jester et al., 2015; Nigg et al., 2004; 2006; Park & Schepp, 2014) and twin studies (Heath et al., 1997; Whitfield et al., 2004) suggests that there is substantial evidence for heritability of problematic alcohol use and alcohol use disorders. In addition to alcohol expectancies and consumption, adults with a positive family history of AUDs also appear to have deficits in executive functioning (Gierski et al., 2013) and greater reward sensitivity (Andrews et al., 2011). This study builds upon previous research by evaluating the interaction between executive functioning and reward sensitivity across college students with and without a family history of alcohol misuse. Family history was classified by parental alcohol "misuse" rather than parental alcohol use disorders per se due to the time and resources required to diagnose an alcohol use disorder, particularly via a secondary source that may not have complete or accurate information (i.e., the child of an individual with a putative disorder). Executive functioning and reward sensitivity were hypothesized to interact to predict more alcohol consumption, more hazardous alcohol consumption, and a greater incidence of alcohol-related problems at a 6-month follow-up, especially among students with a family history of alcohol misuse. Specific interactions are detailed below.

Hypotheses

Main Effect of Executive Functioning:

a) Poorer performance on all three tasks of executive functioning (i.e., inhibition, set-shifting, and updating) was expected to predict greater alcohol consumption (i.e., quantity and frequency), more hazardous alcohol consumption (i.e., binge drinking), and more alcohol-related problems.

Main Effect of Reward Sensitivity:

a) Greater reward sensitivity was hypothesized to predict more alcohol use, more hazardous alcohol use, and more alcohol-related problems across all students.

Specific Interactions

a) Students with a family history of alcohol misuse were expected to have poorer performance on the above executive functioning tasks than students without such history.
b) Students with a family history of alcohol misuse were expected to have greater sensitivity to reward than students without such family history.
c) Greater reward sensitivity was expected to interact with poorer behavioral inhibition to predict more alcohol use, more hazardous alcohol use, and more alcohol-related problems at a 6-month follow-up.
d) The above interaction was hypothesized to be stronger in students with a family history of alcohol misuse, such that these students will consume more alcohol and experience more alcohol-related problems than students without such family history.
e) Based on previous research suggesting that individuals who are better at set-shifting are also more sensitive to reward (Avila et al., 2003), it was hypothesized that greater reward sensitivity will interact with better set-shifting ability to predict *more* alcohol use but *fewer* alcohol-related problems at a 6-month follow-up.

f) The above interaction was predicted to be more prominent in students with a family history of alcohol misuse, such that these students will consume more alcohol but experience fewer alcohol-related problems than students without such family history.

g) Based on previous research about working memory capacity (Ellingson et al., 2014; Patrick, Blair, & Maggs, 2008; Thrush et al., 2008), greater reward sensitivity was hypothesized to interact with greater working memory capacity and updating ability to predict alcohol use but not alcohol-related problems at a 6-month follow-up.

h) The above interaction was predicted to be stronger in students with a family history of alcohol misuse, such that these students will consume more alcohol but experience fewer alcohol-related problems than students without such family history.

CHAPTER THREE: METHOD

Participants

Students were recruited from undergraduate psychology classes at Idaho State University, and there were no restrictions by age, gender, or ethnicity. However, students were excluded from participation if English was not their primary or first language. A total of 532 students were recruited from undergraduate psychology classes over the course of one year. Of those, only 204 elected to participate in Phase II, and only 101 completed the final survey as part of Phase III.

Measures

Alcohol-Related Questionnaires

Children of Alcoholics Screening Test-6 (CAST-6). The CAST-6 is a shortened version of the Children of Alcoholics Screening Test that assesses parental history of problematic alcohol use in adult children (Hodgins et al., 1993). It has demonstrated validity in clinical and non-clinical populations, with acceptable internal and test-retest reliability (Hodgins & Shimp, 1995; Hodgins et al., 1995). It consists of the following questions, which an adult must answer with a yes or no: *1) Have you ever thought that one of your parents had a drinking problem? 2) Did you ever encourage one of your parents to quit drinking? 3) Did you ever argue or fight with a parent when he or she was drinking? 4) Have you ever heard your parents fight when one of them was drunk? 5) Did you ever feel like hiding or emptying a parents' bottle of liquor? 6) Did you ever wish that a parent would stop drinking?* Research suggests that using a cut-off score of 2

or more is an acceptable though liberal standard for identifying an adult child of an alcohol abuser, demonstrating consistency with other measures of parental drinking (Hodgins & Shimp, 1995). Internal consistency of the CAST-6 was excellent for this study (Cronbach's $\alpha = .90$).

NIAAA Alcohol Consumption Questionnaire. The NIAAA Alcohol Consumption Questionnaire is published by the National Institute on Alcohol Abuse and Alcoholism. The measure consists of six questions that evaluate frequency of alcohol consumption and binge drinking in the past 12 months, as well as the maximum number of drinks during a single day in one's lifetime. The questions are treated as distinct outcomes, as quantity and frequency may not necessarily convey the same potential set of risks to a drinker. A NIAAA Task Force (2003) recommended these six questions for all future alcohol researchers based on evidence demonstrating that the pattern of alcohol consumption was more predictive of problematic drinking than the quantity of alcohol consumption. For the purposes of this study, the following questions were specifically analyzed: *1) How often did you engage in binge drinking over the past six months?*, *2) What is the largest number of drinks you consumed in the past six months?*, and *3) How often did you consume this largest number?* Questions two and three were multiplied to estimate frequency of heaviest drinking over the past six months. "Largest number of drinks consumed" was chosen for analysis instead of "typical number of drinks consumed," as the primary outcome of interest was maladaptive alcohol use rather than amount of alcohol use per se.

A timeframe of 12 months was originally recommended by the Task Force with the recognition that different time frames may be more appropriate for certain

populations (e.g., under-aged youth) or research questions. Consequently, the NIAAA Alcohol Consumption Questions were edited to assess amount and frequency of alcohol consumption in the past six months.

Rutgers Alcohol Problem Index Brief (RAPI Brief). The RAPI Brief is a 16-item questionnaire that surveys the frequency of a set of alcohol-related problems within domains of social and interpersonal functioning, impaired control, poor self-concept and self-care, risky or reckless consequences, poor academic outcomes, and physical dependence. The questions are treated as a unitary, count-based outcome. Compared to the full RAPI (White & Labouvie, 1989), the RAPI Brief has demonstrated advantages due to its efficient administration time and its reduced potential for gender bias (Earleywine, LaBrie, & Pedersen, 2008). The RAPI Brief retrospectively assesses the incidence of problems up to one year prior to the assessment date; however, due to the timeline of the three phases of this study, students were only asked about the six months prior to completing the questionnaire. Internal consistency was good at both time points (Cronbach's αs = .853 and .918).

Executive Functioning and General Cognitive Assessments

Delis-Kaplan Executive Function System (D-KEFS) Color-Word Interference. The D-KEFS Color-Word Interference subtest (Delis, Kaplan, & Kramer, 2001) is an adaptation and extension of the traditional Stroop Color and Word Test (Golden, 1978). It measures an individual's inhibition of a prepotent verbal response on two distinct trials. Participants are asked to complete four conditions of the task. On the first two, participants' prepotent responses are prepped by saying aloud patches of color (i.e., Color

condition) or reading aloud color words (i.e., Word condition). In the latter two trials, participants name ink colors rather than read color words (i.e., Inhibition) and pay attention to a rule set to determine whether or not they must read a color word or say an ink color (i.e., Inhibition/Switching). Time to task completion and number of errors are recorded. Two advantages of the D-KEFS adaptation of the traditional Stroop task are that it has been normed with a large sample of adults and children that are demographically and regionally representative of the United States population (Homack, Lee, & Riccio, 2005), and it specifically accounts for inhibition errors via scaled scores.

North American Adult Reading Test (NAART). The NAART is a brief reading test used to estimate verbal crystallized intelligence. Participants are asked to read a list of 35 words with atypical phonetic rules, and they are granted points if the word is pronounced correctly. It has been shown to be a reliable and valid estimator of intellectual ability, related to both age and education (Uttl, 2002).

Operation Span (O-Span) Task. The O-Span task assesses working memory abilities by having participants solve simple math problems while remembering unrelated words that follow each math problem; the test is made additionally challenging by requiring participants to solve each math problem and view its corresponding word within a set timeframe (e.g., eight seconds). For this study, the to-be-recalled words were assigned randomly to math operations, and the words were selected based on their relative representation within the English lexicon; this version of the O-Span has been used in previous studies (Turley-Ames & Whitfield, 2003). Operation-word sequences were presented in increasing set size, such that subjects first completed three trials with a set size of two math problems, then three trials with a set size of three problems, and so

forth to a maximum set size of six problems; participants saw a total of 60 unique combinations of math problems and words. To minimize the possibility of an organization effect on recall of words, test stimuli were assigned randomly to two versions of the task. Participants received a point if they correctly recalled a target word in its appropriate trial *and* correctly solved its corresponding math problem. This scoring procedure was used to discourage participants from recalling more words at the expense of incorrect math problems.

Wisconsin Card Sort Task (WCST). The WCST assesses the ability to display cognitive flexibility in light of changing schedules of reinforcement (Berg, 1948). Specifically, the task requires an individual to sort a series of cards into one of four target card groups, which can be matched by color, shape, and/or number of symbols on the card. (Alternatively, a participant could sort the card into the last group by matching on none of these factors.) These target criteria vary throughout the test, and the participant is informed whether each card has been sorted correctly or incorrectly (i.e., "Right" or "Wrong") before attempting to correctly sort their next card. Once a participant has correctly sorted 10 cards in a row, the criterion for correctness changes (e.g., from color to shape), but the participant is not informed of this. Instead, the participant must utilize his or her cognitive flexibility to deduce the new rule and correctly match as many cards as possible.

Participants are exposed to a maximum of 128 cards during the test. However, if six categories – two each of color, shape, and number – are completed before the participant is exposed to 128 cards, then the test is concluded early. The percentage of

errors committed out of all administered cards serves as an estimate of shifting ability (Miyake et al., 2000).

Reward Sensitivity

BIS/BAS Scales. The Behavioral Inhibition/Activation Scales (BIS/BAS Scales) is a 20-item self-report scale that assesses dispositional approach and avoidance tendencies (Carver & White, 1994). Approach tendencies are assessed via questions subdivided into categories of reward responsiveness, drive for reward, and fun-seeking behaviors, yielding three distinct categories of reward sensitivity. Participants indicate the extent to which they agree with a particular approach or avoidance statement on a 1 to 4 Likert-type scale, with 4 indicating strong agreement and 1 indicating strong disagreement (with no neutral response). The BIS/BAS scales have demonstrated modest internal validity (Heubeck, Wilkinson, & Cologon, 1998) and have been successfully used to predict alcohol use (Franken & Muris, 2006) and alcohol problems (Tapper et al., 2015) in college students. Internal consistency was good across the three subcategories (Cronbach's αs = .78-.93).

Positive Impression Management

Marlowe-Crowne Social Desirability Scale. The Marlowe-Crowne Social Desirability Scale (Crowne & Marlowe, 1960) is a 33-item measure of positive impression management outside the context of psychopathology. That is, it is designed to assess the degree to which one tends to present themselves in an overly positive light

on a series of True/False questions. The questionnaire can be used as an indirect gauge of one's likelihood of endorsing socially undesirable behaviors (e.g., binge drinking).

Plan of Analysis

Data were analyzed using structural equation modeling (SEM), a statistical method that takes a confirmatory (theory-driven) approach to data analysis and provides information regarding the fit (congruence) between the adopted theoretical model and the observed data (Schumacker & Lomax, 2010). All analyses were completed using either IBM SPSS Statistics Data Editor version 22 or MPlus version 7.0 with Mixture and Multilevel add-ons. Model fit was assessed using the chi-square goodness-of-fit statistic, as well as three incremental fit indices: Comparative Fit Index (CFI; Bentler, 1990), Tucker Lewis Index (Tucker & Lewis, 1973) and the root mean square error of approximation (RMSEA; Steiger & Lind, 1980). The goodness-of-fit index measures the degree of difference between the observed covariance matrix (the obtained data), and the implied covariance matrix (the theoretical model). A non-significant χ^2 statistic is desirable, as this suggests that there is not a significant difference between the observed data and the implied theoretical model. A CFI and TLI of .9 or greater indicates adequate fit, while a value of .95 or greater indicates excellent fit (Hu & Bentler, 1995; West, Taylor, & Wu, 2012). After a model was specified, the relationships between observed indicator variables and the latent constructs were examined to determine if any variables significantly differed across the PHP and PHN groups. This was conducted by systematically allowing each variable's factor loading to vary across the two groups and then computing a chi-square difference test to determine if the change was significant. If

a loading was determined to be significantly different across the groups, the more complex model was selected and the next factor loading was compared. If there were no significant differences between the two models, the more parsimonious model was selected.

Finally, multiple-groups analyses were then utilized to determine whether the structural relationships were the same across the PHP and PHN groups.

Power Considerations

The following power estimates were originally made with the hypothesized model outlined during the dissertation proposal (Figure 1). Recommendations for estimating power when using structural equation modeling vary and are usually based on findings from previous studies or number of estimated parameters within the model. These analyses proposed to estimate 28 data points per group (i.e., a total of 56) while estimating a total of 32 parameters across the two groups, leaving 24 degrees of freedom within the structural model (Figure 1). Using root-mean-square error of approximation (RMSEA) as an estimate of fit, MacCallum, Browne, and Sugawara (1996) recommend a sample size of 300 for SEM models with approximately 30 degrees of freedom in order to have sufficient power (i.e., 0.780) to detect the difference between a model with a close fit (RMSEA = .05) and an acceptable fit (RMSEA = .08) to the data. Because MacCallum and colleagues' (1996) strategy compares RMSEA of a model with good fit to the RMSEA of a model with acceptable fit, it is a fairly conservative estimate of sample size. Therefore, this study originally planned to collect 300 participants, or 150 with a positive family history of problematic alcohol use and 150 with a negative family

history of problematic alcohol use. Data analyses were run with 204 participants, and collection of data within Phase II (outlined below) was discontinued due to the significant results observed at that time.

This study ultimately utilized a multi-group, latent factor interaction model to test its hypotheses. These analyses estimated 91 data points and 30 parameters per group (i.e., a total of 182 data points and 60 parameters), resulting in 122 degrees of freedom. In the same article (MacCallum et al., 1996), it was estimated that models with 100 or more degrees of freedom will have sufficient power (i.e., 0.955) to detect the difference between a model with a close fit (RMSEA = .05) and an acceptable fit (RMSEA = .08) from just 200 subjects.

Procedure

Participants were recruited through online advertisement in a research management system (i.e., SONA). Participants completed an informed consent online. Following consent, they were asked to complete the CAST-6, the BIS/BAS Scales, and the RAPI Brief via confidential online surveys. Total time to complete these forms was approximately 15-20 minutes, and these questionnaires were considered "Phase I" of the experiment. Participants received one SONA credit for completing all parts of Phase I.

All subjects who completed Phase I were invited to participate in "Phase II," which typically took place as early as one day to as late as two months following the completion of Phase I; the average length of time was approximately two weeks. Students were contacted via e-mail and invited to meet with a research assistant for approximately an hour and a half to complete the D-KEFS Color-Word Interference Test,

the O-Span task, the Wisconsin Card Sorting Test, the NIAAA Alcohol Consumption Questions, the RAPI Brief, the Marlow-Crowne Social Desirability Scale, and a demographics questionnaire. The questionnaires and executive functioning tasks were administered in a random order across participants to reduce the potential influence of order effects. The measures assessing alcohol use and problems were specific to the past six months only. Altogether, Phase II took approximately one hour to an hour and a half to complete, and participants received three SONA credits for their effort.

Six months after subjects participated in Phase II, they were sent an e-mail invitation to complete an online survey of their recent alcohol use and drinking problems (i.e., Phase III). Questions included the NIAAA Alcohol Consumption Questions and the RAPI Brief, and these surveys were specific to alcohol consumption patterns and problems experienced within the past six months only. Participants were paid $5 for completing the survey, and there were entered into a drawing for a large prize (i.e., a $100 gift card) that took place at the conclusion of the study.

CHAPTER FOUR: RESULTS

Descriptive statistics

Means and standard deviations of all variables collected during all three phases are reported in Table 1. The majority of the sample was female (75%) and European-American (84%). A total of 10% of individuals identified as Hispanic, 3% identified as Native American, 1% identified as African-American, 0.5% identified as Asian-American, and 1.5% identified as "Other." Mean age was 23.36 (*SD* = 6.8). Eighty-four individuals (41%) of the sample of 204 participants who completed Phase II had a score of two or more on the CAST-6 and were therefore assigned to the target group.

Rates of student drinking vary from one college to another (Nelson et al., 2009). The present study's sample of college students appeared to drink slightly more, on average, than that reported in a recent sample of college students enrolled in a midwestern state. A recent survey of 10,535 students enrolled at 4-year-colleges in Minnesota indicated that, on average, 31.7% of female students and 45.2% of male students reported engaging in at least one episode of binge drinking within the past year (Velazquez et al., 2011). Within the present study, 73.7% of female students and 71.2% of male students reported engaging in at least one episode of binge drinking within the past six months. Furthermore, out of a list of 19 potential consequences (e.g., performed poorly on a test) used in the study by Velazquez and colleagues (2011), females endorsed experiencing an average of 8.9 problems (*SE* = 0.5) and males endorsed experiencing an average of 10.5 problems (*SE* = 0.5) over the past year. Although our study only asked about alcohol use experienced within the past 6 months, females reported an average of

3.6 problems (*SD* = 5.0) and males reported an average of 5.1 problems (*SD* = 5.0); our study used the RAPI Brief, and thus participants could endorse up to 16 potential consequences.

Descriptive statistics regarding the sample's age, identified gender, identified ethnicity, and target status (i.e., having a family history of problematic alcohol use) are reported in Table 1. Due to small numbers across several ethnic groups, ethnicity was transformed into a binary variable (i.e., "white" versus "not white") for the sake of statistical comparisons across outcome variables. Independent samples t-tests were used to compare the mean amount of heavy alcohol consumption, frequency of binge drinking, and number of RAPI Brief problems across groups divided by self-identified sex and ethnicity (i.e., "white" versus "not white"). There was no difference in any of the alcohol variables across gender groups (all *p*s > .05). Minority students (*M* = 2.59, *SD* = 2.0) were more likely than white students (*M* = 1.86, *SD* = 1.7) to endorse a greater frequency of binge drinking, which translated to nonwhite students reporting that they engaged in binge drinking activities approximately 3-5 times in the past six months, on average, compared to white students binge drinking approximately 1-2 times in the past six months, on average. However, mean frequency of heaviest alcohol use and RAPI Brief problems did not differ across white and minority students (*p*s > .05). Age, gender, and ethnicity were used as demographic controls in subsequent analyses. Finally, independent samples t-tests revealed that target status was not significantly related to the three alcohol variable (all *p*s > .05).

Zero-order correlations between executive functioning, reward sensitivity, and alcohol use variables are reported in Table 2. There tended to be significant intradomain

correlations (e.g., reward sensitivity variables were highly correlated with each other), but interdomain correlations were inconsistent.

Means and standard deviations for alcohol use variables from Phase II and Phase III are reported in Table 3. Substantial positive skew was noted for the RAPI Brief variable collected at both Phase II (skewness = 2.60, *SE* = .17) and Phase III (skewness = 4.33, *SE* = .24), and as such these variables were transformed using a logarithmic transformation. After this transformation, Phase II RAPI data were normally distributed (skewness = .10, *SE* = .17), and skewness of Phase III RAPI data was significantly improved (skewness = .75, *SE* = .24). Paired sample t-tests were used to compare students' reported alcohol use from Phase II to Phase III. Reported frequency of heavy alcohol use did not change from time one to time two, $t(74) = -0.19$, $p > .05$, nor did reported frequency of binge drinking, $t(68) = -0.96$, $p > .05$. However, the number of problems endorsed on the RAPI Brief decreased from an average of 3.97 (*SD* = 5.0) problems during Phase II to an average of 2.95 (*SD* = 5.5) problems during Phase III, $t(98) = 2.77$, $p < .05$ (Figure 2).

The North American Adult Reading Test (NAART) was hypothesized to be statistically related to executive functioning, and the original intention of the researchers was to control for the influence of crystallized intelligence in all analyses. However, it was suspected that there were administration errors in approximately 36% of the sample, and it was only significantly related to performance on the O-Span, $r(195) = .18$, $p < .05$. It was therefore eliminated from subsequent analyses as a means of controlling for crystallized intelligence.

Scores greater than 22 on the Marlow-Crowne Social Desirability Scale (MC-SDS) were considered high scores, as 23 represented approximately one standard deviation above the mean for this sample. Scores less than 12 were considered low scores. Within the present study's sample, 33 of 204 participants had high MC-SDS scores and 38 had low scores. However, PHP students were no more likely than PHN students to be high scorers, $\chi^2(1, N = 188) = .44, p > .05$. Three one-way ANOVAs examined mean differences in the three alcohol variables across low, medium, and high MC-SDS scorers; only the ANOVA examining frequency of heaviest alcohol use was significant, $F(2, 187) = 3.368, p = .037$. Post-hoc comparisons revealed that high MC-SDS scorers tended to score 0.42 standard deviations lower on the frequency of heaviest alcohol use variable than the medium MC-SDS scorers; the differences between high and low MC-SDS groups were not significant. Therefore, the decision was made to keep high MC-SDS scorers in the analyses.

Missing Data and Attrition

Of the 204 individuals who completed Phase II, 101 completed a brief follow-up survey about their alcohol use and alcohol-related problems six months later. Phase III completers were not statistically different from non-completers based on their age ($t(202) = -0.05, p > .05$), gender ($\chi^2(1, N = 204) = 0.78, p > .05$), target status ($\chi^2(1, N = 204) = 3.51, p > .05$), ethnicity ($\chi^2(1, N = 204) = 1.20, p > .05$), score on the MC-SDS ($t(189) = -0.70, p > .05$), or any of the reward sensitivity, alcohol consumption, alcohol problems, or executive functioning data collected during Phase II (all ps > .05). Despite the fact that target status did not significantly impact attrition, only 35 target status individuals

completed Phase III. Demographic data was not collected as part of Phase I, so comparisons of demographic characteristics of those who did and did not elect to complete Phase II could not be performed.

Missing data was observed across almost all variables. Most data was considered to be either missing at random or missing completely at random (e.g., an executive functioning task was occasionally incorrectly administered, or a student overlooked an item on a questionnaire). Of the reward sensitivity variables, four individuals had their BIS/BAS responses misplaced, so they did not have scores for the BAS Drive, Sensation Seeking, or Reward Responsiveness scales. One respondent did not speak English as a first language, so he was excluded from Phase II. Twelve students omitted at least one question from the MC-SDS, although no student omitted more than one. Two respondents were not administered the Inhibition/Switching trial of the D-KEFS Color-Word Interference Test due to administrator error, six individuals' O-Span scores were disqualified due to their reported use of a strategy (i.e., they had previously been trained how to perform better on the task), and 14 individuals were incorrectly administered the WCST so their scores were not interpretable. Twenty-six students did not complete the binge-drinking frequency question, and 14 did not complete the alcohol quantity (i.e., largest number of drinks multiplied by frequency) questions of the NIAAA Alcohol Consumption Questionnaire of Phase II. It was suspected that the alcohol questions were omitted more often because they were located on the back of a double-sided questionnaire, and three of the four of the paper questionnaires were single-sided.

These missing data patterns were addressed with a full information maximum likelihood estimation (FIML), which was automatically implemented as a feature of the

MPlus statistical program. FIML uses all existing observations within the model to find unbiased population parameter values in the presence of missing data.

Measurement Models for Analyses Performed with Phase II Data

After 204 subjects were collected as part of Phase II, a measurement model was estimated to determine whether the observed indicators measured the latent variables in our proposed analyses well. Executive functioning was constructed using scores from the O-Span, the third trial of the D-KEFS Color-Word Interference Test (i.e., the Inhibition trial), and the standard score calculated from the total errors on the Wisconsin Card Sorting Test. (A higher number of errors on the Wisconsin Card Sorting Test results in lower standard scores.) Reward sensitivity was constructed from the three subscale scores yielded from the BIS/BAS self-report measure (i.e., Drive for Reward, Reward Responsiveness, and Fun Seeking), and maladaptive alcohol use was constructed from total number of errors reported on the RAPI Brief, reported frequency of binge drinking episodes, and reported frequency of the highest amount of alcohol consumed in the past 6 months (Figures 1 and 3).

However, the measurement model was not satisfactorily estimated due to poor fit of the Wisconsin Card Sorting Test variable with the other tests of executive function. That is, performance on the Wisconsin Card Sorting Test was substantially unlike performance on the other two executive tasks, and thus it could not be used to reliably estimate a factor of executive functioning. Therefore, the relationship between performance on the Wisconsin Card Sorting Test and maladaptive alcohol use was estimated with a simple path analysis, and the executive functioning factor was generated

using the O-Span, the Inhibition trial of the D-KEFS Color-Word Interference Test, and the Inhibition/Switching Trial of the D-KEFS Color-Word Interference Test. Chi-square test of model fit, $\chi^2(60) = 56.70$, $p > .05$, and the independence model, $\chi^2(72) = 435.16$, $p < .001$, revealed that the adjusted model fit was excellent: RMSEA < 0.00, CFI = 1.00, TFI = 1.01. Observed variables significantly loaded onto each of their respective latent constructs for executive functioning (βs = .35 - .82), reward sensitivity (drive for reward β = .73, fun seeking β = .74, reward responsiveness β = -.84), and maladaptive alcohol use (βs = .55 - .86). Factor loadings for the observed variables are displayed in Figure 3.

Within the latent construct of executive functioning, systematic comparisons across the two groups were not significantly different for the three cognitive tasks (Inhibition: $\chi^2(1) = 0.47$, $p > .05$; Inhibition/Switching: $\chi^2(1) = .29$, $p > .05$; OSpan: $\chi^2(1) = 0.07$, $p > .05$) across the PHP and PHN groups. For the latent construct of reward sensitivity, systematic comparisons were not significant across the two groups (BAS Drive: $\chi^2(1) = 0.09$, $p > .05$; BAS Fun Seeking: $\chi^2(1) = 0.85$, $p > .05$; BAS Reward Responsiveness: $\chi^2(1) = 0.44$, $p > .05$). Systematic comparisons were also insignificant across the two groups for the latent construct of maladaptive alcohol use (RAPI Brief Total Problems: $\chi^2(1) = 1.28$, $p > .05$; Frequency of Heaviest Use: $\chi^2(1) = 0.451$, $p > .05$; Binge Drinking: $\chi^2(1) = 0.138$, $p > .05$). This pattern of results suggested that the more parsimonious model (i.e., same loadings across groups) should be selected. In summary, the measurement model did not differ across the two groups.

Structural Models for Analyses Performed with Phase II Data

First, a latent factor interaction was created from the executive functioning and reward sensitivity factors (Figure 4). Then, the initial structural model was run while controlling for age, ethnicity, MC-SDS scores, and sex. However, only age ($\beta = -0.28$, $t = -3.12$, $p < .05$) and sex ($\beta = -0.19$, $t = -2.06$, $p < .05$) significantly predicted maladaptive alcohol use. Therefore, a final structural model was created that did not include MC-SDS or ethnicity, and age and sex were constrained to be the same across PHP and PHN students for all subsequent analyses. Within the final model, there were main effects of age ($\beta = -0.27$, $t = -3.18$, $p = .001$), such that younger individuals were more likely to engage in risky drinking and experience alcohol-related problems. A main effect of gender trended toward statistical significance ($\beta = -0.17$, $t = -1.84$, $p = .065$).

Congruent with the methodology for the measurement model, if a regression path was significantly different across groups, the more complex model was selected. If there were no significant differences between the two models, the more parsimonious model (no group differences) was selected. All regression paths were compared using this method. Results indicated that the relationships between reward sensitivity and maladaptive alcohol use ($\chi^2(1) = 0.37$, $p > .05$) and the Wisconsin Card Sorting Test and maladaptive alcohol use ($\chi^2(1) = 0.12$, $p > .05$) were the same across groups. However, the relationship between executive functioning and maladaptive alcohol use trended toward statistical significance ($\chi^2(1) = 3.79$, $p = .052$), and the interaction term between executive functioning and reward sensitivity was significantly different across the two groups ($\chi^2(1) = 4.87$, $p < .05$; Figure 6). Therefore, the final model allowed the paths between (i) executive functioning and maladaptive alcohol use and (ii) the interaction

term and maladaptive alcohol use to be different across groups. All other group comparisons failed to reach statistical significance and were therefore constrained to be the same across groups (Figure 4).

A second, more conservative set of exploratory analyses constrained the executive functioning factor to be the same across the PHP and PHN groups. When constrained in this way, performance on the executive functioning tasks was a significant, positive predictor of maladaptive alcohol use ($\beta = .20$, $t = 2.47$, $p < .05$).

Measurement and Structural models for Analyses Using Phase III Data

The alcohol use and problems data collected in Phase III was not hypothesized to be significantly different from the alcohol data collected during Phase II. As such, a second measurement model was proposed whereby the executive functioning, reward sensitivity, and maladaptive alcohol use factors would remain the same; the only difference would be the addition of another alcohol use factor based on the data from Phase III. It was hypothesized that the Phase II data would predict Phase III data.

In contrast to the model used for Phase II data analyses, this model did not yield an acceptable fit to the data; the chi-square test of model fit was significant ($\chi^2(112) = 169.57$, $p > .001$), and indices of model fit were in a range that was less than ideal (CFI = 0.91, TLI = 0.90, and RMSEA = 0.07). The limited amount of data collected for Phase III might have contributed to the poor model fit, especially when considering how the data was distributed across groups (i.e., only 35 participants within the target group). Therefore, the following adjustments were made to the model based on hypothesized fit and modification indices identified in the output. These correlations were specified

within the model: RAPI Brief problems from Phase II with those from Phase III, frequency of heaviest alcohol use from Phase II with Phase II binge drinking frequency, frequency of heaviest alcohol use from Phase II with fun-seeking from the BIS/BAS scales, and Phase III binge drinking with RAPI Brief problems from Phase III. The correlations between the Phase III maladaptive alcohol use factor and the factors for executive functioning and reward sensitivity were also set to zero to limit the amount of parameters that would need to be estimated within the model. These adjustments yielded a model that had acceptable fit to the data based on the chi-square test of model fit ($\chi^2(108) = 128.73$, $p > .05$) and model fit indices (CFI = 0.97, TLI = 0.96, RMSEA = 0.04). Even so, the model was not stable when conducting comparisons of specific variables within the measurement model across groups and when attempting a structural model. As such, an alternative model for analyzing the data was explored.

This alternative model treated Phase III outcome data as observed variables. These variables were added to the same model identified for Phase II data (see *Measurement models for Analyses Performed with Phase II Data* above) and estimated with simple path analyses (Figure 5). Given the limited sample size for Phase III data across groups, it was hypothesized that this model would be a more stable – if less elegant – means of identifying changes in the alcohol outcome variables from Phase II to Phase III.

As outlined above, multiple-groups analysis was used to determine whether or not the structural groups were different across PHP and PHN groups. First, all relationships were constrained to be the same across both groups, then predictors were systematically varied in a series of nested models to determine if a variable was significant across the

two groups. If no significant differences were noted, the more parsimonious model (i.e., the one assuming both groups are the same) was selected. Groups also did not differ based on any of the relationships between the Phase II and Phase III alcohol outcome measures (all χ^2 values: .08 - .87; all *p*s > .05). Therefore, the model that constrained the variables to be the same (more parsimonious) was selected.

With Phase III data included in the model, age (β = -.30, t = -4.21, p < .001) and gender (β = -.26, t = -2.99, p < .05) were significant predictors of maladaptive alcohol use, such that younger students and those who identified as male were more likely to endorse maladaptive alcohol use. The significant relationships between executive functioning and maladaptive alcohol use (among PHN students) and the interaction term and maladaptive alcohol use (among PHP students) remained unchanged. The Phase III alcohol variables were significantly predicted by the Phase II maladaptive alcohol use factor (Frequency of Heaviest Alcohol Use: β = .71, t = 8.80, p < .001; Binge Drinking: β = .73, t = 12.60, p < .001; and RAPI Brief Problems: β = .68, t = 8.37, p < .001). All other paths failed to reach statistical significance (Figure 5).

CHAPTER FIVE: DISCUSSION

Predicting which college students will engage in risky alcohol consumption and experience alcohol-related problems is an important endeavor. As a whole, college students in the United States drink more heavily than their same-age, non-academic peers (Slutske et al., 2004). Although slightly dated, a multi-site and multi-institute survey of college student drinking patterns found that nearly 85% of students endorsed drinking alcohol at some point within the past year, and approximately 40% of college students engaged in binge drinking within the past two weeks (O'Malley & Johnston, 2002). However, rates of student drinking vary from one college to another (Nelson et al., 2009). The present study's sample of college students appeared to drink slightly more, on average, than that reported in a recent sample of college students enrolled in a midwestern state. A recent survey of 10,535 students enrolled at 4-year-colleges in Minnesota indicated that, on average, 31.7% of female students and 45.2% of male students reported engaging in at least one episode of binge drinking within the past year (Velazquez et al., 2011). As mentioned in the results above, 73.7% of female students and 71.2% of male students reported engaging in at least one episode of binge drinking within the past six months. Furthermore, out of a list of 19 potential consequences (e.g., performed poorly on a test) used in the study by Velazquez and colleagues (2011), females endorsed experiencing an average of 8.9 problems (*SE* = 0.5) and males endorsed experiencing an average of 10.5 problems (*SE* = 0.5) over the past year. Although our study only asked about alcohol use experienced within the past 6 months, females reported an average of 3.6 problems (*SD* = 5.0) and males reported an average of 5.1

problems (*SD* = 5.0); our study used the RAPI Brief, and thus participants could endorse up to 16 potential consequences. Thus, it appears that the present sample engaged in more heavy drinking episodes but experienced roughly the same number of problematic drinking outcomes when compared to students from other colleges. It is unclear how these results impacted the study's conclusions, but one possibility is that the latent maladaptive alcohol use factor may have represented a greater proportion of heavy drinking than problematic drinking, per se. The implications of this are discussed in greater detail below.

Executive functioning and reward sensitivity have been separately identified as risk factors for problematic alcohol consumption. Research in adolescents, college students, and community samples of adults has typically indicated that lower executive abilities and greater reward sensitivity increase the likelihood of problematic alcohol use and related problems, and some studies have identified interactions between the two variables that yield unique vulnerabilities above and beyond either construct alone. Even so, the relationship between these variables has not been studied in college students with (or without) a family history of alcohol problems. This population is worth special consideration as prior research has suggested that having a parent with an alcohol use disorder increases the likelihood of executive functioning and other cognitive difficulties (Polderman, 2006), the development of a substance use disorder (O'Neill, Parra, & Sher, 2001), and alcohol-related problems (Elliott, Carey, & Bonafide, 2012) within the offspring.

The present study used structural equation modeling to examine the influence of these risk factors on alcohol consumption and consequences in college students.

Contrary to our hypothesized findings, performance on the Wisconsin Card Sorting Test and other cognitive tests (i.e., collectively, the executive function factor) did not predict maladaptive alcohol use. This was not terribly surprising as a recent review noted that executive functioning was not consistently impaired in heavy drinking nonclinical samples (Montgomery et al., 2012). This sample was not predominantly "heavy drinking," and it was a sample of college students, who tend to have intact and above average executive functions compared to a typical sample of individuals with alcohol use disorder. Studies have consistently demonstrated deficits in executive functioning among clinical samples of alcohol abusers (Uekermann & Daum, 2007). As poorer executive functioning performance is generally hypothesized to be related to greater alcohol use and problems, the relationship between these variables in college students is likely smaller and thus requires larger samples to demonstrate statistical significance.

However, the relationship between the executive functioning factor and maladaptive alcohol use was nearly statistically significant when comparing the relationship across positive parental history (PHP) and negative parental history (PHN) groups. Closer inspection of the data revealed a strong positive trend between the executive function factor and maladaptive alcohol use among PHN subjects only, and when executive functioning was constrained to be the same across PHP and PHN groups in a second set of exploratory analyses, performance on the executive tasks was significantly, positively related to maladaptive alcohol use. This positive relationship is intriguing because poorer inhibition was predicted to yield greater alcohol consumption and alcohol-related problems, and greater working memory performance was hypothesized to predict greater alcohol consumption. They seem like contradictory

predictions. However, as mentioned above, this sample appeared to have a greater proportion of heavy drinkers (i.e., binge drinkers) when compared to other college samples; even so, the rates of problematic outcomes seemed roughly the same when compared to other samples. One interpretation of this finding, then, is that better executive abilities predicted greater alcohol consumption – *but not necessarily more problems* – among the control group.

The identification of a single latent factor of executive functioning is also interesting because it contributes to the ongoing discussion contrasting executive functioning as an umbrella term versus a collection of distinct abilities (Day et al., 2015). By examining the O-Span and D-KEFS Color-Word Interference as a single latent factor, these findings have intriguing implications about the cognitive resources required by both working memory and inhibition. Perhaps there is something about those shared abilities that increases a student's risk of engaging in maladaptive alcohol use. For example, both tests require efficient processing speed and sustained attentional abilities in order to perform well. Thus, there may be something about processing speed or sustained attentional abilities in college students that makes them more likely to consume heavy amounts of alcohol. This effect was observed even after controlling for the influence of age, which could putatively be one link between abilities like processing speed and greater alcohol consumption (i.e., younger individuals are faster and engage in more risky alcohol consumption).

In addition to the unexpected result documented above, this study failed to demonstrate a main effect between reward sensitivity and maladaptive alcohol use in either the PHP or the PHN group. This was surprising given how research has

documented an increased risk of alcohol consumption and problems in individuals with greater reward sensitivity (Bijttebier et al., 2009; Tapper et al., 2015). It is conceivable that the mode of assessment for the construct of reward sensitivity influenced the study's outcome. Although the BIS/BAS scales have been previously used by some researchers to document the effects of reward sensitivity on alcohol use (e.g., Bijttebier et al., 2009; Patrick, Blair, & Maggs, 2008), a large portion of reward sensitivity research has focused on behavioral representations of reward sensitivity, such as attention to drinking cues (Jonker et al., 2014; Peeters et al., 2012; van Hemel-Ruiter et al., 2015) or positive implicit associations (Day, Kahler, Ahern, & Clark, 2015). Such behavioral measures have an immediacy that may more closely mimic approach tendencies in vivo. Research has not explored whether one reward sensitivity measure should be employed over another given a study's sample characteristics. Therefore, it is possible that an alternative task might have demonstrated a more robust main effect. Given the observed interaction (discussed further below), it is also possible that the BIS/BAS scales were slightly more sensitive to the responses of the PHP group but not the PHN group, resulting in an interaction but not a main effect.

One of the most exciting results of this study was the significant two-way interaction observed within the structural equation model. Specifically, executive functioning and reward sensitivity interacted to predict more maladaptive alcohol use among the PHP group but not among the PHN group (Figure 6). Among PHP students with low reward sensitivity, poorer performance on executive functioning tasks was associated with more maladaptive alcohol use. This was likely due to low executive control over the quantity and frequency of drinking, as well as managing the

consequences of drinking. However, among target students with medium to high reward sensitivity, average and better-than-average executive functioning was associated with more maladaptive alcohol use. These individuals might be overly confident about their abilities to control their behaviors and were therefore more likely to satisfy the urge to drink. However, without separating drinking frequency, quantity, and problems, it was unclear whether these high functioning individuals indeed had more problems or more alcohol use per se.

This interaction partially fits a traditional dual-process model of substance abuse. Such models posit that executive functioning and reward sensitivity are competing forces that shape behavior. A dual-process model of substance abuse examines excessive alcohol use within the context of at least two semi-independent systems: a system that processes fast, automatic and associative appraisals (e.g., the relative reward of an activity or object) and a controlled, reflective system (e.g., self-regulatory behaviors such as executive functioning; Wiers & Stacy, 2006). Research has noted different physiological and neurological processes that underlie these activations (Berridge, 2001), as well as how experiences such as repeated drug use can sensitize and change the "fast, automatic" system (Bechara, Noel, & Crone, 2006). With respect to the present study, this explanation was consistent with the maladaptive alcohol use observed in students who had medium to higher levels of executive functioning; among those students, greater reward sensitivity increased the likelihood of maladaptive alcohol use, but maladaptive alcohol use declined as executive control increased. This model was not consistent with the pattern observed for student with medium to low executive control; for these students,

maladaptive alcohol use increased when reward sensitivity decreased and decreased when reward sensitivity increased.

Given the present data's incomplete consistency with the dual process model, there are several caveats of the model that would be prudent to consider. First, this model has typically been used to characterize behavior within substance use disorders, not heavy social drinking; for example, it has been used to explain outpatient treatment success for individuals with an alcohol use disorder (Cox, Hogan, Kristian, & Race, 2002), and it has been utilized to understand drug-related craving through a cognitive lens (Tiffany, 1990). Furthermore, its use with nonclinical samples of social drinkers has been less consistent and even contraindicated. For example, a study evaluating implicit associations of alcohol across groups of heavy and light drinkers demonstrated strong arousal associations in the heavy drinking group (especially among males) but not the light drinking group (Wiers, van Woerden, Smulders, & de Jong, 2002). A more recent study of college students demonstrated that attentional control (i.e., a top-down regulatory process akin to executive function) did not moderate the relationship between reward sensitivity and alcohol use (Jonker et al., 2014); the researchers hypothesized that individuals without an explicit goal to reduce alcohol intake may not feel the need to control the seeking behavior guided by reward sensitivity. Jonker and colleagues' results are particularly important for explaining a second limitation of the dual-process model, which is that both their study and the present study utilized a self-report measure of reward sensitivity. Given the dual-process model's emphasis on executive abilities that attenuate responses to fast, automatic appraisals, it is unclear whether or not ratings on a self-report questionnaire can be assumed to fit with research utilizing automatic (even

subliminal) gauges of reward sensitivity. Finally, the role of punishment sensitivity (i.e., the Behavioral Inhibition System; Gray, 1970; 1982) was not incorporated into the current analyses. It is unclear whether negative associations generated by the fast, automatic appraisal system would oppose the influence of reward sensitivity and thereby limit alcohol consumption. Given that the sample was drawn from a highly religious region that typically classifies alcohol consumption as a morally objectionable behavior, the influence of punishment sensitivity within the current sample is an intriguing possibility. It is especially interesting because 16% of the sample were "high scorers" on the MC-SDS, punishment sensitivity could be a motivation for positive impression management, and high scorers tended to report a lower frequency of heavy alcohol consumption. Research has suggested that individuals with weak executive control are more reactive to punishment sensitivity, too (van Hemel-Ruiter, de Jong, & Wiers, 2011), so the influence of punishment sensitivity would have been interesting to examine as part of our proposed analyses.

An alternative explanation for the two-way interaction combines aspects of the dual process model with ideas about poor self-monitoring and estimation of abilities. This explanation posits that students with higher levels of executive functioning and high degrees of reward sensitivity were overly confident in their ability to cope with the consequences of their own maladaptive alcohol use. Similar to the dual process model described above, when these individuals were also highly sensitive to the rewards of drinking, they may have allowed themselves to drink excessively due to a belief that they could manage the problems that subsequently developed. As this study combined amount of alcohol use and adverse consequences into a single factor, distinctive patterns

across the outcome variables could not be evaluated; even so, frequency of binge drinking and heavy alcohol use had higher beta loadings for the maladaptive alcohol use factor than did alcohol-related problems, which would support our hypothesis that students' overestimation of executive abilities led to greater alcohol consumption per se.

Finally, one of the most at-risk groups in this interaction was students who had lower executive functioning scores and lower self-reported reward sensitivity. Given that executive abilities tend to vary together, it is possible that these individuals also had greater deficits in self-monitoring which led to an underestimation of their relative reward sensitivity and risk for maladaptive alcohol use. Self-monitoring is thought to be a dissociable component of executive functioning (Salthouse, 2005), and deficits in self-monitoring may be implicated in problematic alcohol use (Giancola et al., 1996). It is unfortunate that self-monitoring abilities were not assessed as part of this study.

In summary, then, the risk of maladaptive alcohol use increased as executive functioning performance worsened among individuals with low reward sensitivity. As executive functioning improved from low to medium performance, individuals with high reward sensitivity experienced an increase in maladaptive alcohol use; risky alcohol use then declined subtly as executive abilities improved from medium to a high performance.

Finally, although attrition limited the use of more sophisticated structural equation modeling, our results suggest that maladaptive alcohol use did not significantly change from Phase II to Phase III. Statistically, there were fewer problems reported on the RAPI Brief at Phase III than there were at Phase II; however, the clinical implications of these changes are small given that only one fewer problem was endorsed at Phase III, on average. It is likely that biases inherent in attrition may also have impacted these results.

That is, students who had poorer-than-average executive abilities or greater-than-average amounts of alcohol use and alcohol-related problems were the least likely to follow-up with the Phase III surveys because their lives were generally more encumbered. Even so, our use of paired t-tests underscores that the decrease in the average number of problems on the RAPI Brief was observed in the students who *did* follow through six months later.

Strengths of the Current Study

To our knowledge, this study is the first to model the combined risk of reward sensitivity and executive functioning on maladaptive alcohol use within the context of family history of alcohol problems. In contrast to much of the extant research on this topic which has looked exclusively at inhibition and updating abilities, this study took a multidimensional perspective of executive functioning which included set-shifting, a construct that has historically received less investigation despite evidence that acute alcohol intoxication directly impacts set-shifting ability (Day et al., 2015). By using structural equation modeling, the relationships between executive functioning, reward sensitivity, and maladaptive alcohol use were able to be examined simultaneously across two groups; this permitted the ability to identify Phase II maladaptive alcohol use as both a predictor and criterion of Phase III alcohol use within the same set of analyses.

Another strength of this study was the ability to demonstrate at least one significant result across the two groups, despite the fact that group assignment was based on results of a retrospective self-report questionnaire rather than a structured diagnostic interview with the parents. Given the limitations of the CAST-6, our findings are likely a conservative estimate of the true relationship between executive functioning, reward

sensitivity, and alcohol-related problems in children of parents with an alcohol use disorder.

Third, these results support prior research that has outlined important distinctions between executive abilities (Miyake et al., 2000), with some caveats that would be vital to consider in future neuropsychological research. The latent factor of "executive functioning" that was initially proposed combined the domains of inhibition, set-shifting, and working memory. Despite the fact that executive abilities may be collectively described as a set of functions that permit the pursuit of goal-oriented behaviors, our model did not support a unified construct of executive functioning. Specifically, performance on the Wisconsin Card Sorting Test was significantly unlike performance on the D-KEFS Color-Word Inhibition Test and on the O-Span. These results are intriguing in that they partially support prior research positing that executive domains are indeed distinct (Miyake et al., 2000) despite their unified goals and, to a certain extent, shared neurological activations (Collette et al., 2005). Indeed, Miyake and colleagues (2000) identified these distinct executive domains by performing an elegant series of exploratory and confirmatory factor analyses to identify appropriate distinctions for common neuropsychological tests. Curiously, however, performance on the O-Span and D-KEFS Color-Word Interference Trials were sufficiently alike to yield a satisfactory latent factor for this study's data. That may be due, at least in part, to the nature of the outcome variables for each task. Specifically, processing speed and reading speed are integral components of both the O-Span and the D-KEFS trials; however, these are not necessary to perform successfully on the Wisconsin Card Sorting Test. The modality of an

outcome variable should therefore be an important consideration for future research using structural equation modeling to analyze executive functioning.

Finally, in addition to using cross-sectional data, this study attempted to model the prospective risk of maladaptive alcohol use in a unique subset of college student; our results suggest that a student's pattern of maladaptive alcohol use is likely to remain stable over the course of at least six months. The distinguishing longitudinal component of this study provides a lens into the stability of maladaptive drinking patterns. Although these results were unsurprising given that no interventions or significant environmental changes were systematically applied, they nonetheless underscore the need to explore and implement services that could reduce hazardous drinking in college students. Previous research has investigated factors implicated in the natural (Vik et al., 2003) and intentional (Hagger, Wong, & Davey, 2015) reduction of drinking behavior in college students; future researchers may wish to consider logistical barriers, feasibility, and potential outcomes for implementing such interventions with other student populations. Students with a family history of maladaptive alcohol use and subtle executive dysfunction could be a target population of particular interest.

Limitations of the Current Study

This study had several flaws that are worth mentioning. One of the most notable was the lack of oversight in training of – and thus a greater number of errors observed for – certain cognitive tests, particularly the NAART. This was unfortunate because studies that evaluate executive abilities typically control for the influence of crystallized intelligence. Thus, it is possible that performance on some of the cognitive tests (e.g., the

Operation Span) was significantly influenced by crystallized intelligence (e.g., familiarity with vocabulary words) rather than working memory per se.

Another limitation within the current study is the researchers' lack of knowledge of participants' medication status. Certain psychostimulants are commonly observed within educational settings to treat a variety of developmental and other cognitive concerns (e.g., ADHD) that can impact learning and academic performance. Therefore, it is very likely that college students are more likely than their same-age, non-college peers to be prescribed a psychostimulant. Research has also suggested that current, consistent treatment of ADHD in young adults reduces the development of alcohol or other substance abuse (Chang et al., 2014). As such, medication status could potentially have had significant impacts on both executive functioning and alcohol consumption, and it is unfortunate that students were not asked to provide a list of their current medications so that this possibility could be addressed.

In addition to medication status, this study did not screen participants for the possibility of learning disabilities or other impairments that may have directly impacted performance on the tests of executive functioning. For example, conditions such as dyslexia or dyscalculia could have slowed reading speed on the D-KEFS Color-Word Interference or significantly impacted participants' ability to complete the O-Span. The incidence of learning disabilities among students pursuing postsecondary education has grown rapidly over the past few decades and was recently estimated at 11% (National Center for Education Statistics, 2016). Therefore, it is unfortunate that information about these conditions was not collected.

Fourth, the Wisconsin Cart Sorting Test is one of the most commonly administered measures in neuropsychological assessments and in nonclinical, research-oriented paradigms assessing executive function (Hogan, 2005). It is very similar to a widely available card game called BLINK™, as well as to games contained within popular "brain training" programs such as Lumosity (lumosity.com). Given that it is highly susceptible to practice effects (particularly in higher functioning individuals; Basso, Bornstein, & Lang, 1999; Tate, Perdices, & Maggiotto, 1998), it is possible that students in both groups had generally higher scores than initially predicted due to their prior experience with video games similar to the ones mentioned here. External influences such as these might have obscured the true relationship between set-shifting and patterns of alcohol consumption.

Fifth, fine distinctions in the relationships between distinct executive abilities and specific alcohol outcomes were not addressed by our analyses. Although the measurement model suggested that the maladaptive alcohol use factor fit the data well, the combination of indicators of heavy alcohol consumption and alcohol-related problems could have obscured certain nuanced findings that were originally hypothesized, such as expecting better working memory to predict greater alcohol consumption and worse working memory to predict more alcohol problems. Even so, combining these and other variables into broad latent factors permitted examination of the constructs more generally, which is more practical in its interpretation.

Finally, target status was assessed via a retrospective self-report questionnaire from the student rather than a formal, diagnostic clinical interview with the parents. Structured interviews are considered the gold standard for appropriate diagnosis, and

results might have been more robust if students were separated into groups based on a parent's alcohol use disorder rather than a history of problematic alcohol use. Furthermore, this study did not ask about ongoing alcohol use by their peers or other individuals sharing their living space. Peer drinking behavior has been shown to be a significant predictor of a college student's drinking behavior through a variety of influences, (e.g., modeling or intense goading; Borsari & Carey, 2001), and as such it would have been helpful to control for this information in our analyses.

Summary and Future Directions

Research into the risk factors for maladaptive alcohol use has previously identified parental alcohol use disorders as a target of concern for offspring. This risk is true for college students as well as clinical samples of adults (Berkowitz & Perkins, 1985). Although the effects in our sample were not robust, there were several reasons to suggest that our results were a conservative estimate of the true relationship between executive functioning, reward sensitivity, and maladaptive alcohol use in college students. Models that have historically been used to explain how reward sensitivity and executive functioning interact to yield an increased risk for developing an alcohol use disorder in clinical populations (e.g., dual process models) could be inappropriate models to apply to college students for several reasons. First, when compared to clinical populations, college students are less likely to have long histories of problematic alcohol use that has shaped their neurological processing of reward and potentially compromised their executive function. Furthermore, as a whole students are less likely to perceive their alcohol use as problematic, and thus they may not experience the same motivation to cut

down their alcohol consumption that clinical populations experience. Lastly, the dual process model is predicated on executive vulnerabilities, and as executive functions tend to correlate with crystallized and fluid intelligence, students' executive abilities are likely to be skewed higher than is typically seen within a clinical population. Even so, this study demonstrated some support for dual process models. Among individuals with medium to high executive abilities, increases in reward sensitivity led to increases in maladaptive alcohol use, and better performance on neuropsychological tests led to modest reductions in maladaptive alcohol use.

Given this study's curious trend suggesting a positive relationship between executive abilities and maladaptive alcohol use in students with a negative parental history of problematic alcohol use – and, moreover, a significant finding when the relationship was constrained to be the same across PHN and PHP groups – future models of college student drinking could explore the characteristics and drinking patterns of students with exceptional cognitive abilities. Previous studies have demonstrated similar positive correlations, such as Patrick, Blair, and Magg's (2008) evidence that higher working memory capacity is related to more alcohol consumption but fewer alcohol related problems. Our analyses loaded binge drinking, heavy drinking, and alcohol problems into a single factor of maladaptive alcohol use, so this study was not able to explore the distinctions between those variables. One possible connection between maladaptive alcohol use and greater executive abilities is age, as younger students tended to perform significantly better on the O-Span and tended to endorse more maladaptive alcohol use. Even so, the trend in this study was observed after controlling for the effects

of age. Additional research is needed to probe the contribution of alternative drinking influences among individuals with greater executive abilities.

This study demonstrated a significant two-way interaction, but the results were not completely consistent with the initial hypotheses. Specifically, target students with poorer executive functioning performance and lower self-reported reward sensitivity tended to have the highest amounts of maladaptive alcohol use. Among students with medium to high levels of executive functioning, reward sensitivity tended to linearly increase the risk of maladaptive alcohol use. Therefore, we suggest that a dual-process model that incorporates poor self-monitoring abilities and students' over-estimation of control would be a better fit for a college student population than traditional dual-process models. Additional research is necessary to test the stability of such a model across multiple samples.

Finally, future studies may wish to consider ways to mitigate the relative risk of family history for developing patterns of alcohol misuse. If cognitive vulnerabilities indeed occur at higher rates in individuals with a family history of alcohol abuse, it may be prudent to explore interventions designed to improve sleep and reduce affective distress in these individuals. These are two readily addressable concerns, and there is some evidence that they occur at higher frequencies in individuals with a family history of alcohol use disorders (Dawson & Grant, 1998; Tarokh et al., 2012); furthermore, research has shown that poor sleep and affective distress both impair cognition (Austin, Mitchell, & Goodwin, 2001; Goodwin, 1997; Kilgore, 2010). As referenced above, recent research suggests that compliance with ADHD medication mitigates the likely development of substance abuse in young adults (Chang et al., 2014). Additional

research may wish to consider other prophylactic steps that could be taken to protect this at-risk population and help reduce deleterious psychological, economic, and health consequences resulting from alcohol abuse.

In conclusion, this study sought to examine the relative risk of family history, executive abilities, and reward sensitivity for maladaptive alcohol use in a sample of college students. Results indicated that the D-KEFS Color-Word Interference (Inhibition) and the Operation-Span (Working Memory) were a better fit for a unified factor of executive functioning than the Wisconsin Card Sorting Test, Color-Word Interference, and O-Span combined. There was a significant, positive relationship between executive functioning and maladaptive alcohol use, which was contrary to what was expected. Students with a family history of alcohol misuse were at a greater risk of maladaptive alcohol use than students without a remarkable family history of alcohol misuse; however, this vulnerability was primarily observed among students with generally poorer performance on executive tasks and low reward sensitivity. It was speculated that these students may have had poor self-monitoring abilities. Furthermore, students with greater executive abilities and high reward sensitivity may have over-estimated their self-control, putting them at greater risk of maladaptive alcohol use. These results have implications for the theoretical structure and applied measurement of executive function, as well as the nuances involved in the assessment of risky alcohol use in college students.

Table 1. Descriptive statistics of the Phase II data.

Age	**Ethnicity**	**Sex**	**Ethnicity (Binary)**	**Positive Parental History (PHP) vs. Negative Parental History (PHN)**
M = 23.4 *SD* = 6.8	European-American: 84.3% Hispanic: 9.8% Native American: 2.9% African-American: 1.0% Asian-American: 0.5% Other: 1.5%	Male: 25.5% Female: 74.5%	"White:" 84.3% "Nonwhite:" 15.7%	PHP: 41.2% PHN: 58.8%

Table 2. Zero Order Correlations for Age, Executive Functioning, Reward Sensitivity, Alcohol Use, and Proposed Control Variables.

		Reward Sensitivity			Executive Functioning				Alcohol Use & Problems			Other	
	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Age													
2. BAS Drive	-0.01												
3. BAS Fun	-0.10	0.48**											
4. BAS Reward Resp.	0.11	0.65**	.61**										
5. CW-3	-0.09	-0.14*	0.04	-0.06									
6. CW-4	-0.02	0.03	0.08	0.02	0.44**								
7. O-Span	-0.16*	0.00	0.09	-0.05	0.19**	0.31							
8. WCST	-0.11	0.03	0.02	-0.05	0.05	-0.06	.14						
9. Alc. Quant.	-0.17*	0.04	0.09	-0.10	0.09	0.16*	-.08	.15					
10. Binge	-0.27**	0.07	0.06	-0.05	0.12	0.15	-.08	.2	0.67**				
11. RAPI	-0.06	-0.07	0.04	-0.12	0.09	0.03	.00	.11	0.46**	0.38**			
15. NAART	0.23**	0.00	0.01	0.16*	0.13	0.11	.18*	-.07	-0.15	-0.15	0.00		
12. MC-SDS	-0.21**	-0.08	-0.04	-0.08	-0.07	-0.06	-.04	.04	-0.06	-0.08	-0.23**	-0.14*	
Mean (SD)	23.4 (6.8)	11.1 (2.5)	11.2 (2.8)	16.2 (4.5)	203.9 (20.3)	207.7 (17.9)	38.7 (8.4)	105.7 (13.9)		2.4 (1.7)	4.0 (5.0)	104.9 (7.5)	17.4 (5.5)
Scale Range	18-53	4-16	4-16	5-20	125-245	140-240	5-57	55-135		1-7	0-35	87.2-125.4	3-31

Table 1. BAS Fun = BAS Fun Seeking subscale; BAS Reward Resp. = BAS Reward Responsiveness; CW-3 = D-KEFS Color Word Interference subtest 3, CW-4 = D-KEFS Color Word Interference subtest 4; Alc. Quant. = frequency of consumption of the greatest number of drinks consumed in the past 6 months; Binge = frequency of binge drinking in the past 6 months. Means and standard deviations for the Alcohol Quantity variable were not reported because they were not meaningfully interpretable. Binge drinking values ranged from 1 = "one to two times in the past year" to 9 = "everyday."
* = $p < .05$; ** = $p < .01$

Table 3. Means and standard deviations for alcohol outcome variables.

	Phase II			Phase III		
	Frequency of Heaviest Alcohol Use in the Past Six Months	**Frequency of Binge Drinking in the Past Six Months**	**RAPI Brief**	**Frequency of Heaviest Alcohol Use in the Past Six Months**	**Frequency of Binge Drinking in the Past Six Months**	**RAPI Brief**
Mean	8.42*	1.98†	3.97	9.73*	2.30†	2.95
SD	8.02	1.77	5.03	10.23	1.88	5.50

***** *These numbers are based on a combination of two separate scales, and thus they do not have a truly meaningful scale. They represent relative frequency of heaviest alcohol use over the past six months, where higher numbers could mean: 1) a relatively large amount of alcohol consumed infrequently, 2) a relatively small amount of alcohol consumed frequently, or 3) some compromise between these extremes.*

† *These numbers are based on an ordinal scale, where 0 = none, 1 = 1-2x in the past six months, 2 = 3-5x in the past six months, 3 = 1x per month, and so on.*

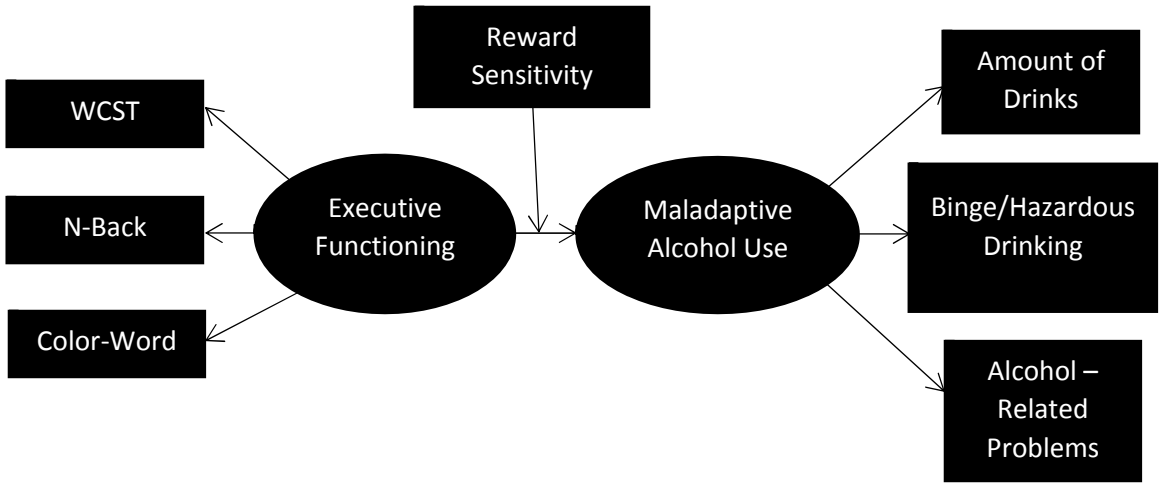

Figure 1. Proposed multi-group structural model.

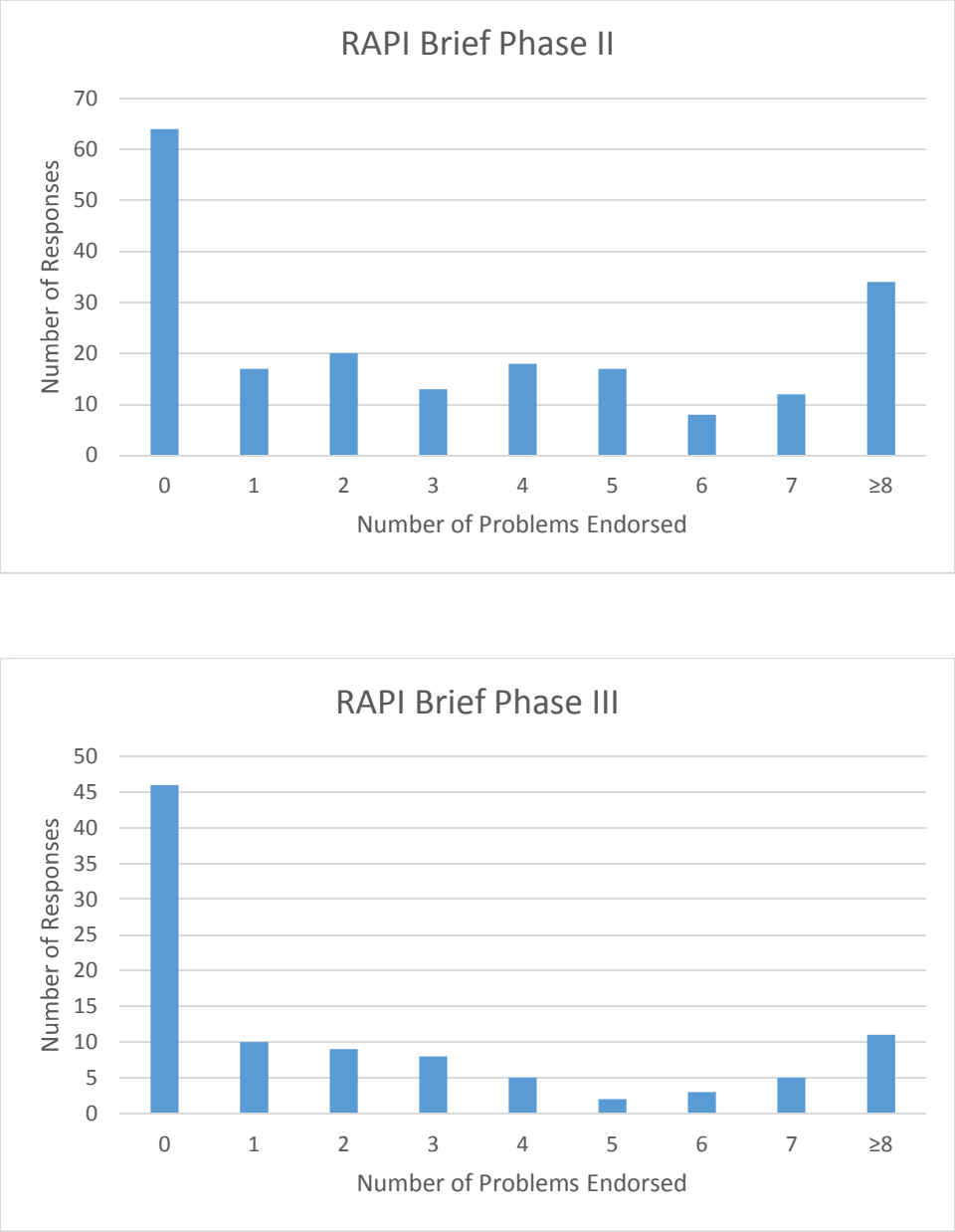

Figure 2. A significant decrease was observed in the number of problems endorsed on the RAPI Brief from Phase II to Phase III.

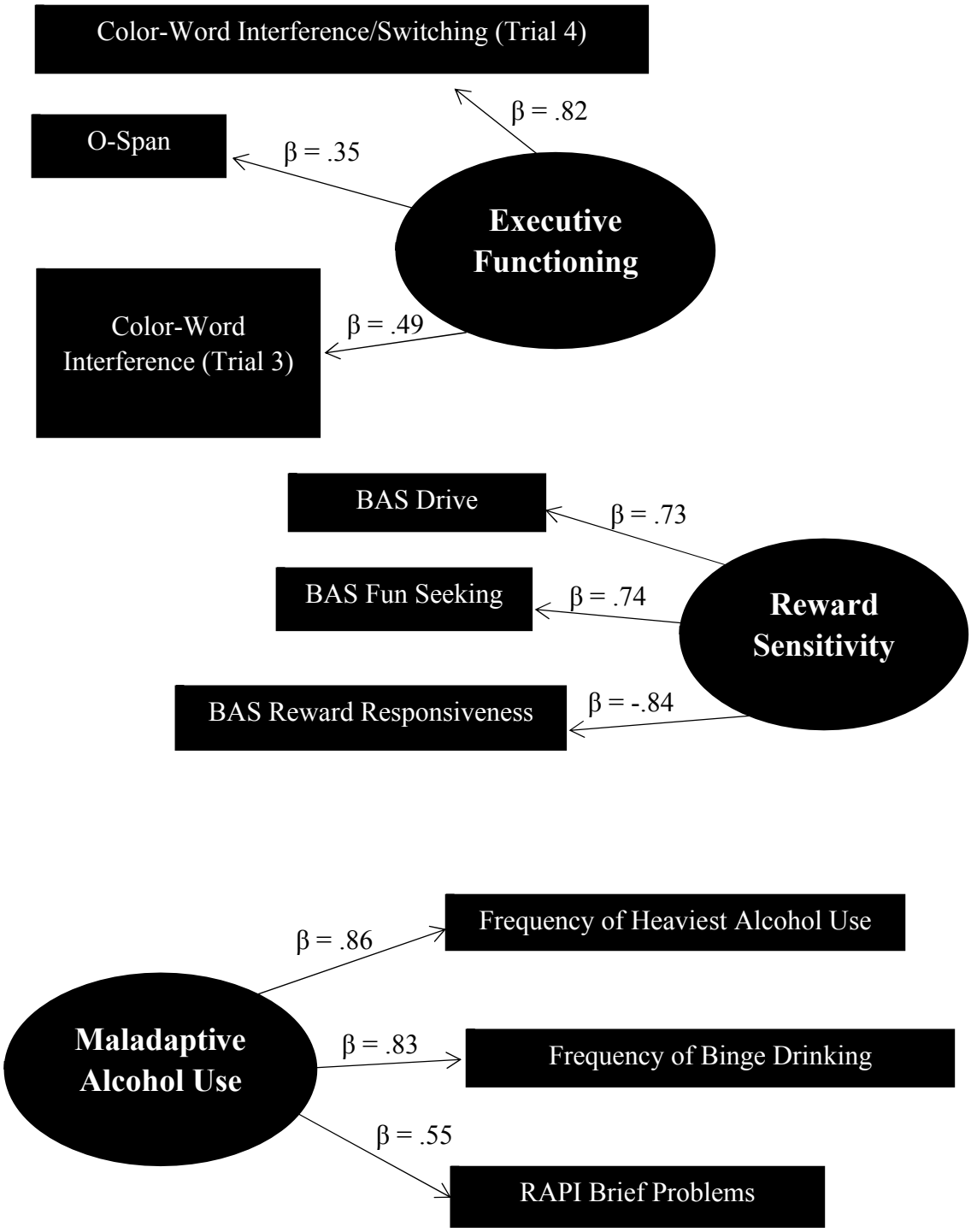

Figure 3. The beta loadings of the latent factors estimated from the measurement model of the Phase II data.

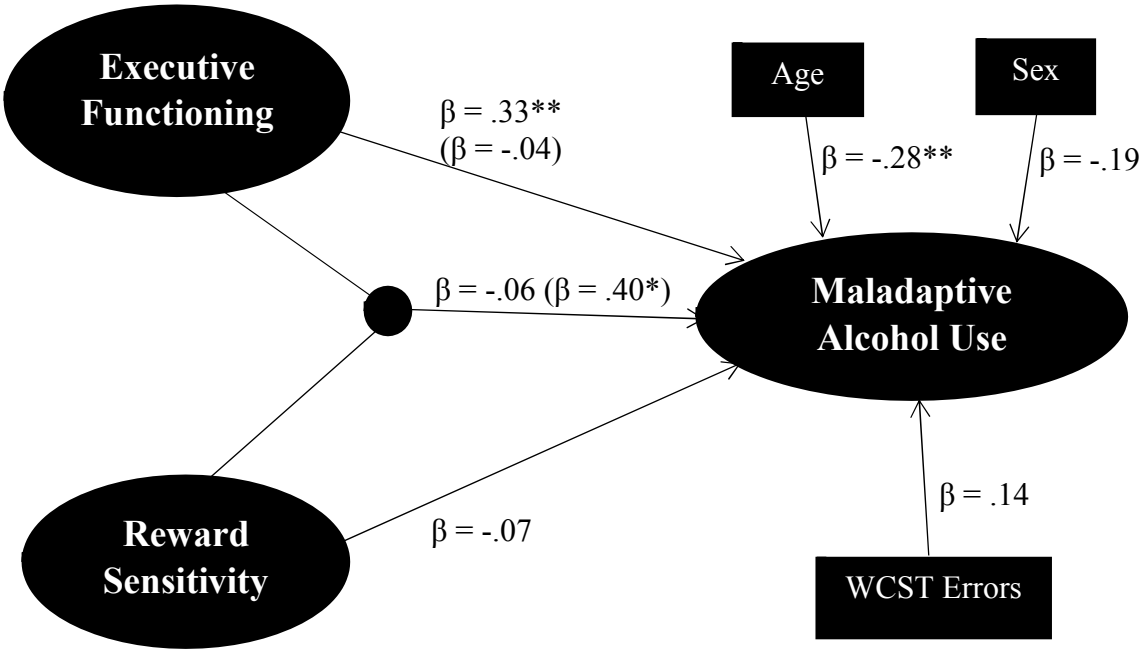

Figure 4. Actual structural model of data from Phases I and II, based on adjustments to model fit. Maladaptive alcohol use's relationships with reward sensitivity, the Wisconsin Card Sorting Test, age, and sex were constrained to be the same across groups. Beta values in parentheses represent values for the target group. * = $p < .05$, ** = $p < .001$

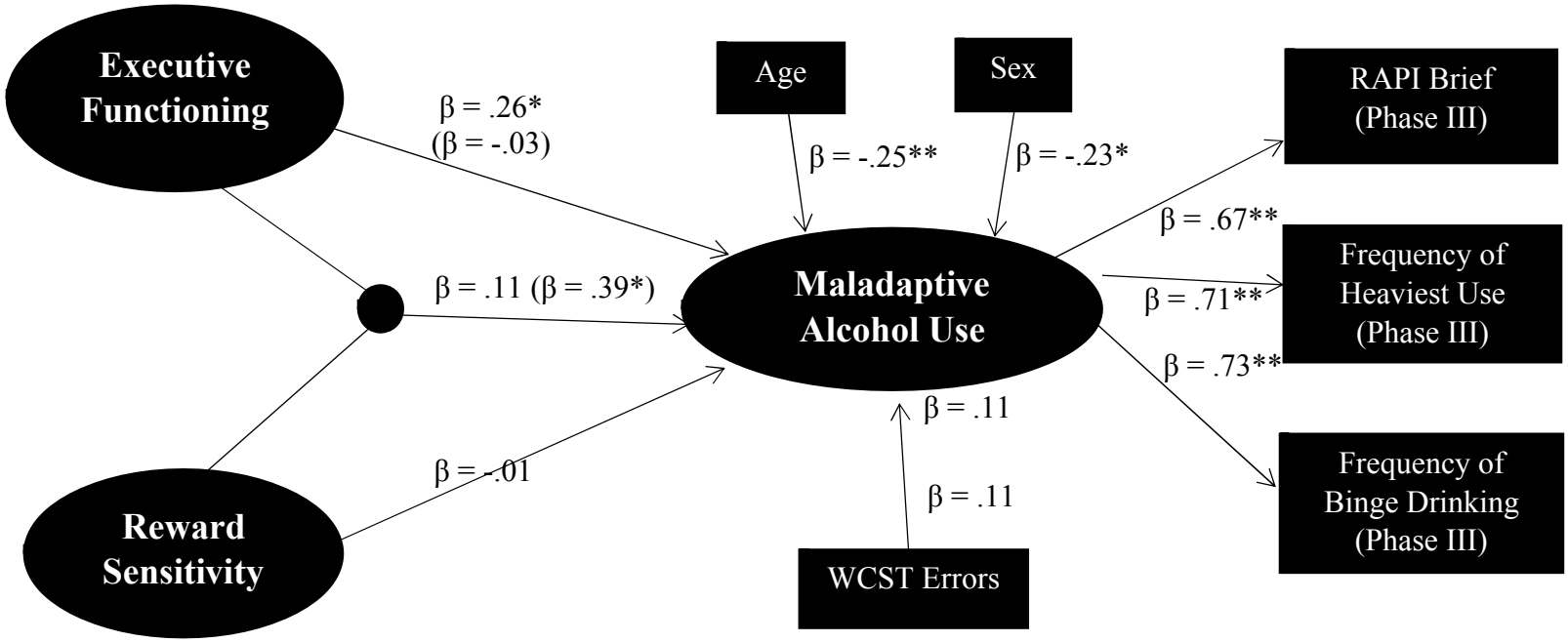

Figure 5. Structural model of data collected from Phases I, II, and III. Beta values in parentheses represent values for the target groups. * = $p < .05$, ** = $p < .00$

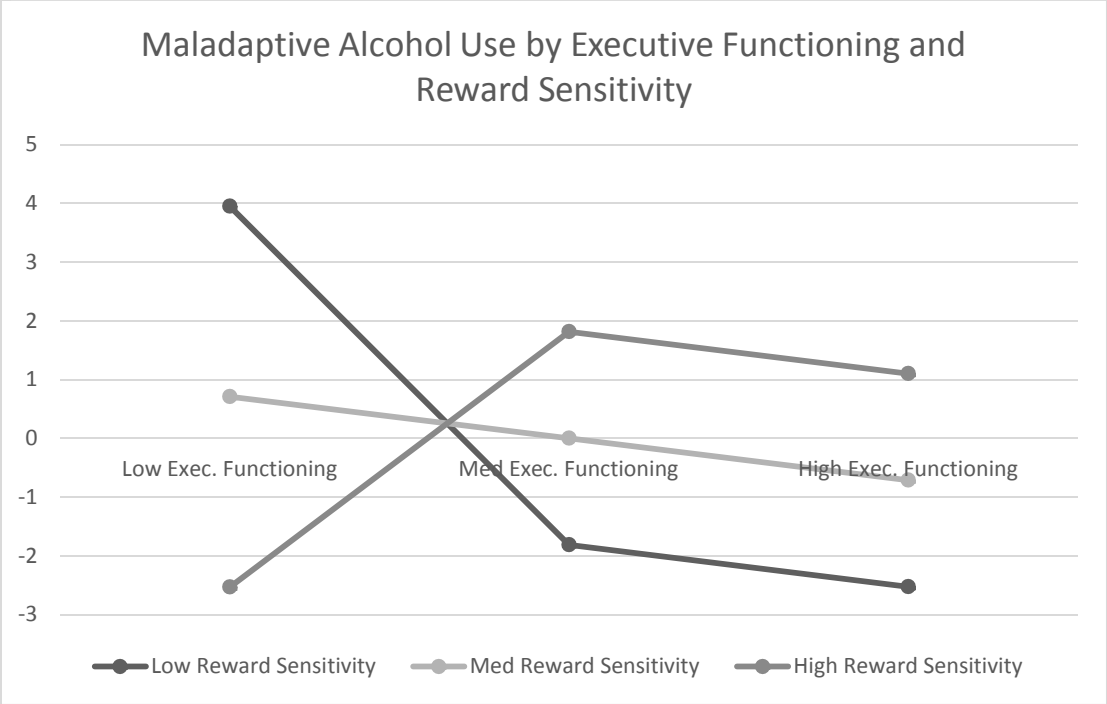

Figure 6. Interaction between reward sensitivity and executive functioning in adults with a family history of alcohol misuse. Numbers greater than zero indicate a greater incidence of heavy drinking and alcohol-related problems. Among individuals with low reward sensitivity, those with low executive functioning tended to have more maladaptive alcohol use. Among individuals with medium reward sensitivity, executive functioning was negatively related to maladaptive alcohol use, but the negative relationship was less pronounced. Among individuals with high reward sensitivity and low to medium executive function, higher executive abilities were associated with more alcohol-related problems. However, among individuals with high reward sensitivity and high executive function, alcohol-related problems did not increase but in fact decreased slightly. In other words, those with high executive abilities were able to exert control over their drinking and avoid maladaptive alcohol use.

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APPENDICES

A. SONA Advertisement

Abstract: Phase I is online, and students can earn 1 SONA credit. Phase II is in a psychology lab, and students can earn 3 SONA credits. Phase III is also online, and students can earn $5 for completing a brief survey.

Description: This study will investigate the relationship between certain cognitive abilities, family history, and other factors that have been shown to impact alcohol consumption. Students participating in this study will be asked to complete a 15-minute survey online, followed by an hour and a half appointment in a psychology lab on ISU's campus. During this appointment, students will answer questionnaires and complete neurocognitive tasks consisting of a card game, a memory task on the computer, and a speeded word-reading task with a research assistant. Students can receive research credit for completing the online and in-person portions of this study. Students will then have the opportunity to earn $5 as well as an entry into a $50 grand prize drawing by completing a follow-up online survey, sent via e-mail invitation, six months after the completion of the neurocognitive tasks.

Eligibility Requirements: Must be 18 years of age or older, a native English speaker, and have consumed alcohol at least once in your life to participate.

B. Consent to Participate in Research

You are being asked to participate in a research study. You do not have to be in this study. If you say yes, you may quit the study at any time. Please take as much time as you want to make your choice.

Why is this study being done?

We want to understand what factors are related to alcohol consumption patterns in college students. This information could ultimately help create a safer campus environment. We are asking students who have consumed alcohol in the past, like you, to participate.

What happens if I say, "Yes, I want to be in the study?"

There are three separate Phases to the study. If you check yes at the bottom of this page, you will start Phase I.

• Phase I consists of a series of questions related to your perceptions of reward and things you enjoy, as well as a few questions related to your parents' alcohol consumption patterns and behaviors. Combined with this consent form, Phase I should take approximately 30 minutes of your time. You will receive 1 SONA credit for participating in Phase I.

• If you are eligible for Phase II, a research assistant will contact you within the next seven days to schedule a time to complete Phase II. This stage will require you meeting a research assistant in a psychology lab, where you will complete three tasks that measure different aspects of your self-regulation and problem-solving abilities. In addition to completing these tasks, you will also be asked to fill out additional questionnaires that ask about demographic information, your previous drinking patterns and behaviors, and specific aspects of your personality. Altogether, Phase II should take approximately 75-90 minutes, and you will receive 3 SONA credits for participating.

• Phase III will take place six months after the completion of Phase II. With your consent, we will send you an e-mail invitation to Phase III. The e-mail will take you to a short online survey where you will answer questions about your drinking behavior for the six months since completing Phase II. The survey is brief and should take approximately 5-10 minutes to complete. You will not receive any SONA credits for Phase III. However, once the survey is finished, you can choose to receive $5 either via a PayPal account transfer or mailed directly to your physical address. You will also be entered into a drawing for the grand prize giveaway, a $50 Visa giftcard, which will be conducted at the end of the study.

You may participate in one, two, or all three of the phases. Agreeing to Phase I today does not mean that you have to participate in Phases II and III.

How long will the study take?

Including the time for informed consent, Phase I should take approximately 30 minutes. Phase II will take about 75-90 minutes, and Phase III should take about 5-10 minutes.

Where will the study take place?

Phases I and III will take place online. Phase II will take place in a research lab at Idaho State Pocatello campus: Garrison Hall, room 502.

What happens if I say, "No, I do not want to be in the study?" Will that affect my grade in my psychology classes?

No one will treat you any differently if you say no. You will not be penalized by the SONA system, and your course instructors will not be informed that you signed up for the study but changed your mind.
However, if you do not at least start the study, you will not receive SONA research credit (which can be applied to your psychology courses, if applicable)! Research credit is often a required part of many psychology classes. However, all classes offer multiple ways to obtain research credit that do not necessitate involvement in research. (For example, you may have the alternative to review several research articles for course credit.) Please consult your individual course instructors if you are unsure about the different ways in which you can obtain research credit.

What happens if I say yes, but change my mind later?

You may stop responding to questions in Phases I and III at any time. You may also stop participating in Phase II at any time. You will not be penalized, but you will only receive SONA credits commensurate with your involvement.

Do you wish to participate in the study, knowing that you can change your mind and stop responding at any time? You will not be penalized in your psychology classes for not participating in the study, although you will not be eligible to earn SONA credit.

_____ Yes (by checking yes, I acknowledge that I have read the Consent information above, and I agree to participate in the study)

_____ No

C. Self-Report Measures

Background Questionnaire

The following questions ask you about your use of alcohol, and alcohol use by your friends and family members. Your responses to these questions are **COMPLETELY CONFIDENTIAL** and are for research purposes only. Please answer honestly as we will not share this information with anyone.

1. How old are you? _____years
2. Male or female? (circle one) M F
3. Year in college: (circle one) Freshman Sophomore Junior Senior (4+)
4. What is your current weight? _____lbs
5. Where do you currently live?

1. At home with family [parent(s) and/or siblings]
2. In dormitories
3. On own with roommates
4. On own without roommates
5. At home with family [spouse and/or children]
6. Fraternity or Sorority

6. Do you currently attend church?

    1. Never or Not applicable
    2. No, not at the present time
    3. Yes, but not regularly
    4. Yes, regularly

7. What do you consider your main cultural background?

    1. Caucasian
    2. Latino/Latina
    3. Native American
    4. Asian or Asian-American
    5. African-American
    6. Other

8. Marital Status:

_____single

_____living with romantic partner: Age when you moved in together_____

_____married: Age when you got married_____

_____separated/divorced: Age when you got separated or divorced_____

9. How many children do you have? _____

    How old is your youngest child? _____

    How old is your oldest child? _____

10. Employment status:

_____not currently working

_____part-time, non-career position; had job since age _____

_____part-time, career position; had job since age _____

_____full-time, non-career position; had job since age _____

_____full-time, career position; had job since age _____

BIS/BAS

Each item of this questionnaire is a statement that a person may either agree with or disagree with. For each item, indicate how much you agree or disagree with what the item says. Please respond to all the items; do not leave any blank. Choose only one response to each statement. Please be as accurate and honest as you can be. Respond to each item as if it were the only item. That is, don't worry about being "consistent" in your responses. Choose from the following four response options:

1 = very true for me

2 = somewhat true for me

3 = somewhat false for me

4 = very false for me

1. A person's family is the most important thing in life.
2. Even if something bad is about to happen to me, I rarely experience fear or nervousness.
3. I go out of my way to get things I want.
4. When I'm doing well at something I love to keep at it.
5. I'm always willing to try something new if I think it will be fun.
6. How I dress is important to me.
7. When I get something I want, I feel excited and energized.
8. Criticism or scolding hurts me quite a bit.
9. When I want something I usually go all-out to get it.
10. I will often do things for no other reason than that they might be fun.

11. It's hard for me to find the time to do things such as get a haircut.
12. If I see a chance to get something I want I move on it right away.
13. I feel pretty worried or upset when I think or know somebody is angry at me.
14. When I see an opportunity for something I like I get excited right away.
15. I often act on the spur of the moment.
16. If I think something unpleasant is going to happen I usually get pretty "worked up."
17. I often wonder why people act the way they do.
18. When good things happen to me, it affects me strongly.
19. I feel worried when I think I have done poorly at something important.
20. I crave excitement and new sensations.

21. When I go after something I use a "no holds barred" approach.
22. I have very few fears compared to my friends.
23. It would excite me to win a contest.
24. I worry about making mistakes.

CAST-6

Have you ever thought that one of your parents had a drinking problem?

Did you ever encourage one of your parents to quit drinking?

Did you ever argue or fight with a parent when he or she was drinking?

Have you ever heard your parents fight when one of them was drunk?

Did you ever feel like hiding or emptying a parents' bottle of liquor?

Did you ever wish that a parent would stop drinking?

National Institute on Alcohol Abuse and Alcoholism (NIAAA) Questions

1. During the last 6 months, how often did you usually have any kind of drink containing alcohol?

By a drink we mean half an ounce of absolute alcohol (e.g. a 12 ounce can or glass of beer or cooler, a 5 ounce glass of wine, or a drink containing 1 shot of liquor). *Choose only one.*

_____ Every day
_____ 5 to 6 times a week
_____ 3 to 4 times a week
_____ twice a week
_____ once a week
_____ 2 to 3 times a month
_____ once a month
_____ 3 to 11 times in the past year
_____ 1 or 2 times in the past year

_____ **I did not drink any alcohol in the past six months, but I did drink in the past**
(COMPLETE QUESTION 1A, then STOP!)

_____ **I never drank any alcohol in my life**
(Stop here, done with alcohol questions.)

1A - During your LIFETIME, what is the maximum number of drinks containing alcohol that you drank within a 24-hour period? (asked here only of those who did not drink any alcohol during the past 12 months)

_____ 36 drinks or more
_____ 24 to 35 drinks
_____ 18 to 23 drinks
_____ 12 to 17 drinks
_____ 8 to 11 drinks
_____ 5 to 7 drinks
_____ 4 drinks
_____ 3 drinks
_____ 2 drinks
_____ 1 drink

2. During the last 6 months, how many alcoholic drinks did you have on a typical day when you drank alcohol?

_____ 25 or more drinks
_____ 19 to 24 drinks
_____ 16 to 18 drinks
_____ 12 to 15 drinks
_____ 9 to 11 drinks
_____ 7 to 8 drinks
_____ 5 to 6 drinks
_____ 3 to 4 drinks
_____ 2 drinks
_____ 1 drink

3. During the last 6 months, what is the largest number of drinks containing alcohol that you drank within a 24-hour period?

_____ 36 drinks or more
_____ 24 to 35 drinks
_____ 18 to 23 drinks
_____ 12 to 17 drinks
_____ 8 to 11 drinks
_____ 5 to 7 drinks
_____ 4 drinks
_____ 3 drinks
_____ 2 drinks
_____ 1 drink

4. During the last 6 months, how often did you drink this largest number of drinks? Choose only one.

_____ Every day
_____ 5 to 6 times a week
_____ 3 to 4 times a week
_____ twice a week
_____ once a week
_____ 2 to 3 times a month
_____ once a month
_____ 3 to 11 times in the past year
_____ 1 or 2 times in the past year

5. During the last 12 months, how often did you have 5 or more (males) or 4 or more (females) drinks containing any kind of alcohol in within a two-hour period? [That would be the equivalent of at least 5 (4) 12-ounce cans or bottles of beer, 5 (4) five ounce glasses of wine, 5 (4) drinks each containing one shot of liquor or spirits - to be provided by interviewer if asked.] Choose only one.

_____ Every day
_____ 5 to 6 days a week
_____ 3 to 4 days a week
_____ two days a week
_____ one day a week
_____ 2 to 3 days a month
_____ one day a month
_____ 3 to 11 days in the past year
_____ 1 or 2 days in the past year

6. During your lifetime, what is the largest number of drinks containing alcohol that you drank within a 24-hour period?

_____ 36 drinks or more
_____ 24 to 35 drinks
_____ 18 to 23 drinks
_____ 12 to 17 drinks
_____ 8 to 11 drinks
_____ 5 to 7 drinks
_____ 4 drinks
_____ 3 drinks
_____ 2 drinks
_____ 1 drink

RAPI Brief

Different things happen to people while they are drinking ALCOHOL or because of their ALCOHOL drinking. Several of these things are listed below. Indicate how many times each of these things happened to you **WITHIN THE LAST 6 MONTHS**:

Use the following code:

0 = None

1 = 1-2 times

2 = 3-5 times

3 = More than 5 times

HOW MANY TIMES HAS THIS HAPPENED TO YOU WHILE YOU WERE DRINKING OR BECAUSE OF YOUR DRINKING DURING THE LAST YEAR? (CIRCLE ONE)

0	1	2	3	Not able to do your homework or study for a test.
0	1	2	3	Got into fights with other people (friends, relatives, strangers).
0	1	2	3	Caused shame or embarrassment to someone.
0	1	2	3	Neglected your responsibilities
0	1	2	3	Relatives avoided you
0	1	2	3	Felt that you needed more alcohol than you used in order to get the same effect
0	1	2	3	Tried to control your drinking (tried to drink only at certain times of the day or in certain places, that is, tried to change your pattern of drinking)
0	1	2	3	Had withdrawal symptoms, that is, felt sick because you stopped or cut down on drinking
0	1	2	3	Felt that you had a problem with alcohol
0	1	2	3	Missed a day (or part of a day) of school or work
0	1	2	3	Wanted to stop drinking but couldn't
0	1	2	3	Suddenly found yourself in a place that you could not remember getting to
0	1	2	3	Felt you were going crazy
0	1	2	3	Had a bad time
0	1	2	3	Felt physically or psychologically dependent on alcohol
0	1	2	3	Was told by a friend, neighbor, or relative to stop or cut down drinking

Marlowe-Crowne Social Desirability Scale

Please reach each statement and circle either true (T) or false (F).

1. Before voting, I thoroughly investigate the qualifications of all the candidates. T F
2. I never hesitate to go out of my way to help someone in trouble. T F
3. It is sometimes hard for me to go on with my work if I am not encouraged. T F
4. I have never intensely disliked anyone. T F
5. On occasion, I have had doubts about my ability to succeed in life. T F
6. I sometimes feel resentful when I don't get my way. T F
7. I am always careful about my manner of dress. T F
8. My table manners at home are as good as when I eat out in a restaurant. T F
9. If I could get into a movie without paying and be sure I was not seen, I would probably do it. T F
10. On a few occasions, I have given up something because I thought too little of my ability. T F
11. I like to gossip at times. T F
12. There have been times when I felt like rebelling against people in authority even though I knew they were right. T F
13. No matter who I'm talking to, I'm always a good listener. T F
14. I can remember "playing sick" to get out of something. T F
15. There have been occasions when I have taken advantage of someone. T F
16. I'm always willing to admit it when I make a mistake. T F
17. I always try to practice what I preach. T F
18. I don't find it particularly difficult to get along with loudmouthed, obnoxious people. T F
19. I sometimes try to get even rather than forgive and forget. T F
20. When I don't know something I don't mind at all admitting it. T F
21. I am always courteous, even to people who are disagreeable. T F
22. At times I have really insisted on having things my own way. T F
23. There have been occasions when I felt like smashing things. T F
24. I would never think of letting someone else be punished for my wrong-doings. T F
25. I never resent being asked to return a favor. T F
26. I have never been irked when people expressed ideas very different from my own. T F
27. I never make a long trip without checking the safety of my car. T F
28. There have been times when I was quite jealous of the good fortune of others. T F
29. I have almost never felt the urge to tell someone off. T F
30. I am sometimes irritated by people who ask favors of me. T F
31. I have never felt that I was punished without cause. T F
32. I sometimes think when people have a misfortune they only got what they deserved. T F
33. I have never deliberately said something that hurt someone's feelings. T F