ATTENTION AND METACOGNITION IN THE ELABORATED INTRUSION THEORY OF DESIRE

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The elaborated intrusion (EI) theory of desire is a cognitive model that describes the processes involved in craving as intrusive thoughts that are elaborated upon leading to dissonance when desires are not met. While the theory is based on a wide body of research, certain theoretical predictions have not been fully examined. Specifically, EI theory argues that mental imagery has a central role in craving, and predicts that attempts to suppress substance-related intrusive thoughts and mental imagery is related to increased craving. Further, EI theory suggests that elaboration of craving imagery is related to attention and working memory processes, however, there are questions about whether differential performance in these domains is related to craving. The current study examined the relationship between attention/working memory performance and alcohol craving in a sample of 119 young adult males. Additionally, metacognition was examined to clarify the phenomenological aspects of craving within EI theory. Attention and working memory performance did not significantly predict intrusive thought and mental imagery elaboration. Individuals with high craving reported significantly higher levels of anxiety, thought suppression, and greater strength and frequency of craving-related mental imagery. They were also more likely to try to control their own thoughts and make negative judgments on their ability to do so. The strength of craving-related intrusive thoughts, not mental imagery, was the most significant predictor of craving. Implications for the understanding of craving and treatment recommendations based on the findings are discussed.
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ACKNOWLEDGMENTS

This work is dedicated to my parents Bob and Teal Yates and my sister Tori Yates who have provided me with the support needed to achieve my dreams. I would also like to thank all those who have provided me with inspiration over the years including those who are no longer with us.
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CHAPTER 1
INTRODUCTION

Over the last century, numerous models have been proposed to explain the phenomenon of craving. Specific types of models advanced have included conditioning models, cognitive models, psychobiological models, and motivational models (Skinner & Aubin, 2010). While craving is considered to be an important construct, various theoretical models have defined craving differently due to its multifaceted nature. Specifically, craving has been argued to involve characteristics such as: a subjective state of desire, a physiological response, or a combination of psychological and biological processes. This ambivalence in the properties of craving is troubling given the proposed changes related to addiction disorders for the Diagnostic and Statistical Manual of Mental Disorders – 5th Edition (O’Brien, 2010). Particularly, it has been proposed that craving be added as a diagnostic symptom for addiction disorders with the potential for craving to be used dimensionally to determine addiction severity. With these proposed changes in mind, it may be helpful to provide additional empirical grounding for theoretical models of craving.

As mentioned, the various theoretical models that describe aspects of craving have included conditioning models, cognitive models, psychobiological models, and motivational models among others (Skinner & Aubin, 2010). The conditioning models that have been proposed include the withdrawal model (Wikler, 1948), the opponent-process model (Solomon & Corbit, 1974), the compensatory response model (Siegel, 1983), and the incentive model (Stewart, de Wit, & Eikelboom, 1984). The conditioning models are based on the principles of classical and operant conditioning and argue that craving is a response to rewards and the removal of withdrawal symptoms.
The cognitive models proposed have included the dual affect model (Baker, Morse, & Sherman, 1986), the cognitive processing model (Tiffany, 1999), the affective processing model of negative reinforcement (Baker, Piper, McCarthy, Majeskie, & Fiore, 2004), and the outcome expectancy model (Marlatt, 1985). These models are focused on aspects of craving related to information processing and other mental processes. Some examples of the types of processes examined by these models include: memory, emotions, and expectations (Skinner & Aubin, 2010).

The psychobiological models previously proposed are numerous including: the three pathway psychobiological model of craving (Verheul, Van Den Brink, & Geerlings, 1999), the theory of neural opponent motivation (Koob & Le Moal, 1997), the incentive sensitization model (Robinson & Berridge, 1993), the united framework for addiction (Redish, Jensen, & Johnson, 2008), the temporal-difference reinforcement learning model (Redish, 2004), the model of interoceptive dysregulation (Paulus, Tapert, & Schulteis, 2009), and the neuroanatomical model (Anton, 1999). While numerous, these models have in common a focus on the neural systems involved in craving that are usually studied via brain imaging and neurochemistry (Skinner & Aubin, 2010).

Finally, the motivational models that have been proposed have included the motivational model of alcohol use (Cox & Klinger, 1988), prime theory (West, 2006), and the multidimensional ambivalence model (Breiner, Stritzke, & Lang, 1999). The motivational models, as suggested by their namesake, focus on the motivational properties of substance abuse and how these properties are related to craving (Skinner & Aubin, 2010).

Each of the previously described models advance their own predictions related to craving, and include support through research findings (Skinner & Aubin, 2010). As a result,
there is little consensus in how to operationalize craving as a construct. In response to this difficulty with integrating various fields of research, Kavanagh, Andrade, and May (2005) devised a more comprehensive model of craving: the elaborated intrusion (EI) theory of desire. This theory attempts to account for the most substantive and consistent research findings related to craving and desire in general. While EI theory is ultimately a cognitive theory, it includes elements of motivational theories, conditioning theories, and principles of psychobiology. This makes the theory unique in that it attempts to incorporate seemingly disparate findings and different levels of analysis. The theory also proposes that desire is a continuum with the term craving reserved for more extreme examples of desire, usually related to alcohol and other drug use.

Elaborated Intrusion (EI) Theory of Desire

EI theory holds that desire is a complex mechanism involving both non-conscious and conscious processes (Andrade, May, & Kavanagh, 2009). Importantly, these processes are believed to be similar in desires for food, alcohol, nicotine, and other drugs such as cocaine, heroin, or alprazolam. According to EI theory, specific triggers such as physiological deficit states (e.g. withdrawal, hunger), external cues (e.g. substance-related advertisements), negative affect (e.g. sadness, anxiety), substance-related cognitions (e.g. recall of an event at a recent party), or anticipatory responses (e.g. feelings of relaxation) lead to a non-conscious associative process. The associations may be memories of previous drug use occasions, images of substances, smells, or sounds (such as the clanking of beer bottles), among many other forms of related stimuli. After these associations are built to a certain level, they enter into conscious awareness in the form of an intrusive thought. An example of such an intrusive thought is a
fleeting image of eating a favorite dessert, or enjoying the smell of a favored alcoholic beverage. This intrusive thought may be ignored in situations where an individual is intently focused on a competing cognitive demand. However, in situations where cognitive resources are sufficiently available, the intrusive thought may be attended to. Once attended to, Kavanagh, Andrade, and May (2005) argue that a conscious elaborative process takes place where further mental imagery related to the substance is cognitively constructed. An example of this type of elaborative process (using the previous example of the smell of a favored alcoholic beverage) is thinking about where the last alcoholic beverage was consumed, who was present at that time, what the beverage tasted like, and how to attain the beverage. The elaborative process is initially viewed as pleasurable; however, it has the potential to strengthen the awareness of the need (or desire) for a substance which can lead to negative affect. When this process occurs, elaborated intrusive thoughts can lead to craving (a strong sense of wanting a substance cognitively, physiologically, and/or affectively). Importantly, the content of the non-conscious associative process and the elaborated intrusive thought can be the same. The main difference is in the awareness or subjective experience of the cognition, as well as the cognitive processes that occur related to the cognition.

EI theory accounts for some of the most consistent research findings related to craving of addictive substances and desire in general by combining findings from cognitive research, neuropsychological research, brain imaging, conditioning theory, and research on biological and neurobiological aspects of craving and addiction (Kavanagh, Andrade, & May, 2005). Specifically, EI theory is multi-directional. It is assumed that cognitions can lead to the recognition of a physiological deficit state, induce affective states, or physiologically trigger heightened arousal related to craving. Alternatively, a physiological deficit state, conditioned
stimulus, affect, or thought can trigger the associative processes involved in elaborated intrusion. A key component believed to underlie craving, according to Kavanagh, Andrade, and May (2005), is mental imagery. Mental imagery is also supported as a component of craving indirectly by neurobiological and neurocognitive models that identify brain processes and regions related to working memory, executive function, attention, and emotion as fundamental aspects of craving (Hommer, 1999; Hugh et al., 2004; Wilson, Sayette, & Fiez, 2004; Skinner & Aubin, 2010). However, EI theory also makes several assumptions that have not been thoroughly tested. Specifically, EI theory proposes that intrusive thoughts differ from elaborated thoughts, that cognitive imagery capacity is a significant component of craving, that the associative process involved in elaborated intrusion relies on attention and working memory, that affectively charged mental imagery leads to stronger craving, and that attempts to suppress craving-related mental imagery leads to stronger craving (Kavanagh, May, & Andrade, 2009).

Several recent studies have examined the theoretical assumptions of EI theory, especially related to the role of imagery in desire (craving). Kemps and Tiggemann (2009) reported a three-part study that examined the sensory modality of craving imagery in relation to coffee cravings, as well as, whether or not competing visual or olfactory imagery could reduce craving for coffee in comparison to auditory imagery. In the first part of the study, Kemps and Tiggemann asked 106 female coffee drinkers to visualize coffee and report which sensory modalities were involved in their imagery. The sensory modalities most often reported as being involved in coffee craving included the olfactory, visual, and gustatory modalities. Next, the researchers conducted two experiments with 90 female college students that induced craving for coffee by presenting coffee-related images and actual coffee, respectively, and attempting to reduce craving using tasks that involved competing sensory modalities. In the first experiment, coffee-
related images were presented to induce craving and then the participants were asked to complete one of three tasks: a visual task, an auditory task, or an olfactory task. Because the auditory task involved a sensory modality not reported as highly involved in coffee craving, this task served as a control group. The results showed that the intensity of coffee-related craving was reduced by the olfactory and visual tasks, but not the auditory task. Finally, the authors completed the same experimental manipulation using actual coffee to induce craving. The results of the final experiment mirrored the results of the previous experiment as both the olfactory and visual tasks reduced craving but not the auditory task. This study highlights the importance of imagery in craving while also showing that craving imagery involves multiple sensory modalities. Additionally, the study shows the practical nature of EI theory as the results indicate that tasks that compete with imagery involved in craving can reduce subjective levels of craving.

The idea that imagery is critical to craving and desire in general was also explored in a four-part study by May, Andrade, Panabokke, and Kavanagh (2010). In order to explore the role of imagery in craving, the researchers examined the impact of tasks designed to compete with visual imagery. In the first part of the experiment, the researchers randomly assigned a group of 40 undergraduate students who reported smoking cigarettes into deprived and non-deprived groups. The individuals in the deprived group were instructed to stop smoking at midnight the night before the study, while the individuals in the non-deprived group were instructed to smoke as usual. The individuals in each group were further divided so that half of the individuals in each group completed a visual imagery task and the other half completed an auditory imagery task. A script was read before completing the imagery tasks to increase craving for cigarettes, and ratings of craving were taken before and after completing the tasks. The results showed that the auditory imagery task had no impact on either group but that the visual imagery task reduced
craving in both groups. This result provided evidence for the impact of visual imagery in craving for cigarettes. In the second part of the study, the researchers used the same method but replaced the visual imagery task with a non-imagery task that was designed to interfere with visual working memory. The results of the experiment replicated the findings of the previous experiment and showed that interfering with the processes used in visual imagery can reduce craving for cigarettes. In the third part of the experiment, the researchers used the same methodology. However, the researchers replaced the craving induction script with questions about cigarette smoking to make it less obvious that they were concerned with craving. The same tasks used in the first part of the study were employed. However, unlike the results from the first part of the study, the results for the third part indicated that visual and auditory tasks did not reduce craving but stopped it from increasing. The authors attributed this difference to the fact that they allowed the participants to keep their cigarettes, and the possibility that the individuals included in the study did not abstain from smoking as required. Finally, in the fourth part of the study, the researchers had 34 undergraduate smokers abstain from smoking overnight. Then, two groups were created by matching the individuals on levels of craving and emotion. One group of individuals completed a task involving counting backwards from 100 to 0, and the other group completed a novel visual sensory memory task which involved creating shapes with modeling clay. After comparing the two groups, it was found that the novel task stopped craving in the individuals from increasing; however, craving increased for the individuals completing the task involving counting backwards from 100 to 0. The researchers concluded that the novel task was as effective at stopping increases in cigarette cravings as the visual task used in the third part of the experiment. Overall, the results of these experiments show that visual imagery is an
important factor involved in craving for cigarettes and that tasks that interfere with visual imagery can be used to reduce cravings.

One aspect of EI theory not examined in the previous studies involves the availability of specific information related to craving in memory. That is, EI theory suggests that craving involves intrusive thoughts, and as such, information specifically related to the substance being craved should act like a priming stimulus in episodic or semantic memory for individuals likely to experience craving (Berry, Andrade, & May, 2005). In order to examine this aspect of EI theory experimentally, Berry, Andrade, and May (2005) randomly assigned 56 undergraduate students to either a hungry or satiated condition in a food craving study. Individuals in the hungry condition were asked not to eat breakfast or lunch on the day of the experiment, whereas the individuals in the satiated condition were asked to eat both breakfast and lunch. The individuals were then assessed using a lexical decision task with neutral and food-related words. Individuals that were assigned to the hungry condition were found to show significantly higher levels of semantic priming for food-related items than the individuals assigned to the satiated condition. Additionally, individuals in the hungry condition showed slower response times to neutral words than individuals in the satiated condition. The researchers argued that the slowed response times to neutral words in individuals in the hungry condition were due to slowed cognitive performance from hunger. Whereas, the faster response times to food related words in individuals in the hungry condition were due to a higher level of semantic priming related to the availability of information in memory. Further, the researchers concluded that this finding indicates that individuals in a deficit state are primed in a way that could increase the likelihood of experiencing an intrusive thought as suggested by EI theory.
Finally, in a study designed to explore five general hypotheses related to EI theory, Kavanagh, May, and Andrade (2009) examined whether: 1) craving intensity was related to craving imagery, 2) there was a difference between craving-related intrusions and elaborations, 3) thought suppression of craving was related to more frequent intrusions, 4) alcohol consumption was related to craving, and 5) negative affect was related to craving. In order to examine these five hypotheses, the researchers developed the Alcohol Craving Experience (ACE) questionnaire to measure the intensity and duration of craving, metacognitive aspects of craving, and craving-related imagery. Participants were recruited to complete the study through mail and telephone from a group of individuals completing a randomized controlled trial for a cognitive-behavioral treatment for alcohol use disorders. A total of 283 individuals completed all components of the study. The participants were mailed the ACE as well as several other instruments including the Alcohol Use Disorders Identification Test, the Severity of Alcohol Dependence Questionnaire, and the Kessler 10 (a measure of psychological distress). Individuals were also interviewed by telephone using the Composite International Diagnostic Interview to determine whether they met DSM-IV criteria for an alcohol use disorder. A correlational analysis of the participants’ responses on the surveys was used to test the five study hypotheses. The results indicated that alcohol image frequency was positively related to stronger craving, that alcohol image intrusions and elaborations involved separate processes, that increased attempts at thought suppression were related to more frequent and intense craving, that alcohol use was positively correlated with alcohol craving, and that negative affect was correlated positively with frequency, length, and intensity of craving. These results provide support for the theoretical assumptions of EI theory; however, the study was correlational in design, and thus, cannot prove a causal link between elaborated intrusion and craving.
In sum, EI theory incorporates research that supports several theories and models of craving in an attempt to account for seemingly disparate findings (Kavanagh, Andrade, & May, 2005). A key concept that plays a role in accounting for the findings from these various lines of research is mental imagery. As such, findings from research examining neurobiology, affect, neurocognition, physiology, motivation, and conditioning are incorporated through the subjective experience of the intrusive thoughts involved in elaborated intrusion, as well as the imagery involved in perpetuating the intrusive thoughts, and the processes involved in cognitive elaboration. EI theory allows one to make specific predictions and hypotheses related to craving, some of which have been explored (Kemps & Tiggemann, 2009; May, Andrade, Panabokke, & Kavanagh, 2010; Berry, Andrade, & May, 2005; Kavanagh, May, & Andrade, 2009). However, other aspects of EI theory have not been explored fully including the role of metacognition in elaborated intrusion, the role of attention and working memory in EI theory, and the relationship of these aspects of the theory to affect and craving imagery.

Metacognition

Components of Metacognition

As previously suggested, one of the predictions of EI theory (Kavanagh, Andrade, & May, 2005) is that the intrusive thoughts involved in craving will show properties similar to intrusive thoughts involved in other forms of psychopathology. Specifically, it has been theorized that individuals experiencing intrusive thoughts will become trapped in a ruminative cycle whereby they think about and try to control their intrusive thoughts (Anton, 1999). As such, the beliefs that individuals hold about their competence in controlling intrusive thoughts, as
well as the control strategies they use, may be correlated with higher levels of craving, craving imagery, and negative affect (Kavanagh, Andrade, & May).

The process where individuals attempt to understand and control their own thoughts, as well as understand the thoughts of others, is termed metacognition (Flavell, 1979). More broadly, metacognition can be viewed as thinking about thinking. Many attempts have been made to identify the different components involved in metacognition. As with many constructs in the field of psychology, one way to operationalize the components of metacognition is through the psychological instruments designed to measure it. Through the use of factor analysis, factors (or components) can be identified in groups of items included in a psychological instrument that represent aspects of the underlying construct (Wells & Cartwright-Hatton, 2004). One measure of metacognition that has generated significant research and is considered to accurately represent the construct of metacognition is the Meta-Cognitions Questionnaire (Cartwright-Hatton & Wells, 1997). The Meta-Cognitions Questionnaire (MCQ) has five subscales that are believed to reflect the theoretical components of metacognition: positive beliefs about worry, negative beliefs about thoughts concerning uncontrollability and danger, cognitive confidence in attention and memory, negative beliefs concerning the consequences of not controlling thoughts, and cognitive self-consciousness. A shorter version of the questionnaire, the Metacognitions Questionnaire – 30 (MCQ-30), has also been developed that has the same factor structure as the longer version (Wells & Cartwright-Hatton). The factors tapped by these questionnaires have been found to show strong construct validity through their correlation with symptoms of obsessive-compulsive disorder, pathological worry, depression, and other forms of psychopathology that are tied metacognition. As such, the five factors that underlie the MCQ and
MCQ-30 are believed to represent an accurate portrayal of specific components involved in metacognition.

*Intrusive Thoughts and Metacognition*

In a study examining craving and metacognition, Toneatto (1999) argued that craving is itself a form of metacognition. It should be noted that some might consider EI theory antithetical to Toneatto’s idea, given that EI theory suggests that craving is a complex psychophysiological state that involves more than just cognition or metacognition. However, the assumptions outlined by Toneatto are not necessarily in opposition with EI theory. Specifically, Toneatto wrote that “construing cravings as metacognitions is an indication that the individual is experiencing cognitive events, such as discursive thinking, feelings, memories, perceptions, sensations, dreams, or images, that the individual appraises as aversive and wishes to modify as rapidly as possible” (p. 530). This conception of craving as the experience of cognitive events seems similar to the process of elaborated intrusion described by EI theory. Further, EI theory postulates that the elaboration of intrusive thoughts is initially viewed as pleasurable, but has the potential to raise negative affect through the recognition of a deficit state (Kavanagh, Andrade, & May, 2005). Similarly, Toneatto argued that once an individual recognizes craving metacognitions as aversive, the motivation to consume alcohol (or other substances) would increase in order to both reduce cognitive dissonance created by negative metacognitions, as well as to provide the pleasurable effects of the item being craved, and/or to reduce the stress or anxiety caused by the aversive state. Regardless of the theoretical differences as to how craving is conceptualized as a whole, it is still important to understand the effect of metacognition in the subjective phenomenological experience of craving. It may be that the intrusive, ruminative,
nature of craving-related cognitions have the potential to increase negative affect, as well as raise physiological arousal, to a point where the motivation to consume a substance is increased beyond that which an individual feels capable of controlling. As such, it is important to understand these phenomenological aspects of craving and metacognition.

The idea that craving involves intrusive thoughts has also been examined from a more objectively operationalized perspective. Anton (1999) reported that areas of the brain identified as being activated during craving, using brain imaging techniques such as functional magnetic resonance imaging (fMRI), include the dorsolateral prefrontal cortex, amygdala, nucleus accumbens, and basal ganglia. Further, these areas are similar to the brain regions involved in obsessive-compulsive disorder. In both the thoughts involved in obsessive-compulsive disorder and intrusive thoughts involved in craving, these brain regions have been correlated to subjective reports of thought intrusion. Additionally, Anton reported that there are similarities between obsessive-compulsive disorder and craving such as obsessive and intrusive thoughts, and compulsions to engage in specific behaviors. These findings highlight the importance of intrusive thoughts in craving, provide some support for EI theory, and provide support to the view of craving as a form of metacognition (e.g., representation in dorsolateral prefrontal cortex) involving affect/motivation (e.g., amygdala activation).

In addition to findings showing that craving involves aspects of metacognition, some research suggests that affective processes may moderate the relationship between intrusive craving-related thoughts and metacognitive strategies. In a study that examined the relationship between metacognition and intrusive thoughts related to craving for cigarettes, Nosen and Woody (2009) explored the meaning individuals attach to obsessive thoughts and their attempts to suppress such thoughts. Specifically, these authors reported that individuals tend to attach
personal meanings to obsessive thoughts. They indicated that individuals tend to overestimate the importance of the intrusive thoughts, have incorrect beliefs about the consequences of having the thoughts (e.g. having the thoughts means I am crazy or weak), and have an irrational desire to maintain control over the thoughts. As a result of these appraisals of their intrusive thoughts, the researchers indicated that individuals tend to negatively evaluate themselves when they have difficulty controlling the thoughts, and that they attach overly personal meanings to their thoughts (e.g. I am incapable). To examine this relationship, Nosen and Woody had 180 adults complete several questionnaires online including: the Appraisals of Craving Questionnaire, the Catastrophic Appraisals Index, the Obsessional Beliefs Questionnaire, the Thought-Action Fusion Scale, the Obsessive Compulsive Drinking Scale – Smoking Version, the Center for Epidemiological Studies Depression Scale – Short Form, the Smoking Efficacy Questionnaire, the Smoking Effects Questionnaire, and the Fagerstrom Test for Nicotine Dependence. Correlational analyses were conducted and the researchers found that the individuals experienced more significant nicotine cravings if they evaluated their intrusive thoughts related to cigarettes as more personally meaningful, more catastrophic, and more important to control. The researchers did not find evidence that attempts to suppress intrusive thoughts led to higher levels of craving; however, they did find that attempts at suppressing intrusive thoughts were related to a metacognitive approach involving negative evaluations of one’s ability to regulate cognition. Thus, it seems that the meaning an individual attributes to craving-related intrusive thoughts may play a role in the elaborated intrusion process of EI theory. Specifically, individuals who attach overly personal meaning to their intrusive thoughts may be processing the thoughts differently than other individuals. These individuals may view their inability to regulate craving-related intrusive thoughts as indicating that they are somehow deficient. This may lead to a cycle of
negative affect involving negative self-appraisals which could make it more difficult to control future intrusive thoughts or inhibit substance use (Nosen & Woody).

**Affective Appraisal of Metacognitions and Thought Suppression**

One of the stated tenets of EI theory is that craving involves intrusive thoughts that are initially viewed as pleasurable, and are thus elaborated upon (Kavanagh, Andrade, & May, 2005). However, these thoughts have the potential to lead to the recognition of a deficit state that drives the desire to consume a substance. It is believed that, at this time, the initially pleasurable intrusive thoughts become negative and result in feelings of distress. The fact that individuals who attach more significant personal meanings to their intrusive thoughts are more likely to engage in attempts to suppress the thoughts, supports the idea that individuals believe their thought control strategies can effectively regulate their emotions (Nosen & Woody, 2009).

Caselli and Spada (2010) examined the phenomenological aspects of metacognition and craving-related thoughts using a semi-structured interview in 24 people classified as either individuals with an alcohol use disorder, individuals with pathological gambling addiction, individuals classified as having bulimia nervosa, or individuals who were nicotine dependent. They found that the individuals believed that engaging in metacognitive strategies related to the intrusive thoughts involved in craving helped them to regulate their emotion, increased positive sensations, and improved their control over their behavior. Further, the individuals believed that metacognitions related to craving had negative effects on executive control, cognitive performance, and self-image. The researchers suggested that individuals in the study attempted to use metacognitive strategies to control their desire-related thoughts, but that they felt the strategies did not work. Additionally, Caselli and Spada speculated that experiencing failure of
non-productive metacognitive strategies, which an individual believes to be successful at regulating emotion, could result in a ruminative loop of trying harder to use the same failed strategy. This could result in a negative view of the self that makes it even more difficult to control craving-related thoughts. This type of relationship has been found in other psychological disorders involving metacognition, especially with respect to post-traumatic stress disorder (Shipherd & Salters-Pedneault, 2008).

Berry, May, Andrade, and Kavanagh (2010), suggested that continued attempts to employ failed thought suppression strategies in craving involves similar processes to those identified in earlier thought suppression experiments by Wegner, Schneider, Carter, and White (1987). For instance, Wegner et al. found that attempting to suppress thoughts actually increases the salience of the thoughts, and results in a rebound effect whereby the tendency to engage in behavior related to the thoughts is increased when attempts at suppression are ceased. In addition, Berry et al. stated that individual differences in cognitive abilities such as working memory capacity are likely to regulate how successful attempts at thought suppression are. Finally, Berry et al. argued that changing the focus of attention by engaging in a cognitively demanding task may better relieve craving-related thoughts than thought suppression.

Interestingly, Wegner and Zanakos (1994) expanded on the earlier findings by Wegner, Schneider, Carter, and White (1987), and reported that it is possible to measure an individual’s tendency to use thought suppression strategies on a daily basis. In earlier studies on thought suppression, laboratory-based strategies were used; however, this reduced the opportunity to gauge whether an individual employed thought suppression strategies outside of the laboratory. Wegner and Zanakos created the White Bear Suppression Inventory to measure an individual’s tendency to use thought suppression to avoid obsessive thoughts and negative emotions more
generally. Individuals who score highly on the White Bear Suppression Inventory have a tendency to engage in thought suppression on a chronic basis, have a tendency to engage in obsessional thinking, and have a tendency to try to suppress negative thoughts with the ironic effect of increasing them. As such, measuring thought suppression strategies in individuals who experience high levels of craving, as well as understanding individuals’ appraisals of their thought control strategies is an important research avenue to examine. To date, examination of non-productive thought suppression strategies in conjunction with metacognition has not been fully explored in relation to craving imagery, and may help in further articulation of EI theory (Kavanagh, Andrade, & May, 2005).

One study, though not specific to craving-related imagery, bears some relevance to the current topic. Behar, Vescio, and Borkovec (2005) studied thought suppression in 89 undergraduate students by comparing thought suppression for imagery-based cognitions (e.g. “is that a hungry white bear?”) and thought suppression for thought-based cognitions (e.g. “hope I don’t run out of gas”) in suppressing worrisome versus neutral stimuli. The researchers found that individuals who engaged in suppression for imagery-based cognitions had reduced worrisome cognitions in comparison to individuals attempting to suppress thought-based cognitions. Unexpectedly, no rebound effect was found for either group of individuals after ceasing the thought suppression strategy. Because studies related to the effect of using thought suppression for imagery-based cognitions is limited, it is difficult to generalize the results of this study to desire or craving. Additionally, this line of research raises questions about whether there is a difference between craving-related intrusive thoughts and craving-related mental imagery.

While it has been theorized that failed attempts at thought suppression will lead to a rebound effect, little research has supported this notion (Erskine, Georgiou, & Kvavilashvili,
To address this issue more formally, Erskine, Georgiou, and Kvavilsahvili experimentally examined thought suppression related to cigarette smoking in 85 individuals. The individuals were divided into three groups including a group instructed to suppress all smoking related thoughts, a group asked to express all smoking related thoughts, and a control group of individuals who did not take part in the manipulation. All individuals reported their stress levels and the number of cigarettes they smoked for three weeks while using the strategy they were assigned to. For the first week of the study the individuals smoked as usual, for the second week they were asked to use the strategy they were assigned to, and for the third week they were asked to smoke as usual again. Individuals in the group asked to suppress smoking related thoughts were found to smoke less during the second week than the other two groups, but smoked significantly more during the third week than the other two groups. As such, the results revealed that using thought suppression strategies worked for a limited period of time, but then resulted in a behavioral rebound. Similar results were found in a study examining suppression related to food (Erskine & Georgiou, 2010).

Based on the results of these studies, it is clear that metacognition plays a role in the intrusive thoughts and elaborative processes involved in craving. Little research to date, however, has examined the relationship between metacognition, including thought suppression, and craving-related mental imagery. Additionally, Berry, May, Andrade, and Kavanagh (2010) speculated that individual differences in working memory and attention should be related to the ability to succeed with thought suppression strategies. Unfortunately, these relationships have not been fully examined in relation to craving imagery. Understanding how individuals appraise their metacognitive thoughts and beliefs also appears to be important to fully understanding craving. Finally, individuals’ appraisal of their thoughts is likely related to their affective
experience, and may be involved to the extent that they use thought suppression, as well as how successful they are at controlling craving-related intrusive thoughts.

Attention and Working Memory

Models of Attention and Working Memory

Since EI theory (Kavanagh, Andrade, & May, 2005) proposes that many of the cognitive processes involved in craving occur through the attentional and working memory systems, it is important to briefly review these systems. Attention and working memory are two interrelated systems (Awh, Vogel, & Oh, 2006). Attention involves the ability to control the focus of one’s cognitive resources, to select relevant information for processing, and to help with the encoding process. Working memory is a limited short-term memory store where information can be manipulated and held for more in-depth processing using other cognitive operations. Attention is sometimes described as the gatekeeper for working memory as the contents of working memory are often accessed and manipulated through the attentional system. This occurs through the focus of attention on information that is relevant for processing in working memory. Several models have been created to explain the attention and working memory systems. One of the earliest models of attention developed by Posner and Boies (1971) postulated that there are three “senses” of attention including: selective attention, alertness, and vigilance. According to this model, selective attention involves a bias of attention whereby extraneous information is disregarded while important information is focused on. Alertness involves being sensitive to the environment and in a prepared state to recognize information. Finally, vigilance involves the ability to maintain attention over a long period of time.
The early theory of attention developed by Posner and Boies has been expanded over time to included either four or five total components. Additional processes that have been identified have included: spatial attention, focused attention, attentional switching, and divided attention (Goldhammer, Moosbrugger, & Schweizer, 2007). Spatial attention involves shifting attention without changing the focus of the eyes, focused attention involves maintaining attention while disregarding extraneous information, attentional switching involves changing the focus of attention, and divided attention is the ability to complete two or more mental tasks at the same time. One model of attention that has received a significant amount of research support is a four-component model of attention developed by Mirsky, Anthony, Duncan, Ahearn, and Kellam (1991). This model simplifies and reduces the components of attention to components that are able to be measured using neurocognitive tasks. The four components involved include: focus, sustain, shift, and encode. The four-component model by Mirsky et al. has been validated on individuals across the lifespan (Thaler, Allen, Park, McMurray, & Mayfield, 2010). As such, this model provides a good theoretical framework for the current study.

In addition to models that describe the components of attention, specific aspects of working memory have been described through a structural model. Baddeley and Hitch (1974) proposed the multicomponent model of working memory that describes theorized aspects of the working memory system. According to Baddeley and Hitch (2000), working memory is composed of a central executive, a phonological loop, an episodic buffer, and a visuo-spatial sketchpad. The central executive in this model is responsible for coordinating and regulating the other three components. The visuo-spatial sketchpad is a short-term memory store for visual information, and is also responsible for spatial planning. The phonological loop is a short-term memory store for auditory information in which a rehearsal component can be used to maintain
auditory information for longer periods of time. Finally, the episodic buffer is a short-term memory store that is involved in incorporating information in the other components and sequentially organizing that information.

As stated before, it has been hypothesized that working memory and attention are involved in the maintenance and suppression of craving-related intrusive thoughts (Berry, May, Andrade, & Kavanagh, 2010; Andrade, May, & Kavanagh, 2005). However, little research has comprehensively examined the relationship between craving imagery, metacognition, thought suppression, and the attention and working memory systems.

A previous study by the current author (Yates, 2011), examined craving for alcohol in relation to executive function and family history of alcohol abuse in a sample of 121 young adults. Specifically, five separate executive function component processes were explored, including: mental set-shifting, sustained attention, planning, updating of working memory, and inhibition. We found a significant interaction between family history of alcohol abuse and sustained attention in predicting alcohol craving. However, due to problems in the breakdown of participants by gender, we were unable to explore the role of gender in this relationship. Regardless, the results of the study provided support for the relationship between craving and attention as described by Kavanagh, Andrade, and May (2005). Further, the study showed support for a specific deficit in attention in those with a family history of alcohol abuse in relation to alcohol craving.

Andrade, May, and Kavanagh (2005), also hypothesized that craving-related intrusive thoughts would be related to an attentional bias for craving-related stimuli. A significant body of literature exists for the relationship between craving and attentional biases, but little research has examined the phenomenological aspects of craving-related metacognitions in relation to
attentional bias. For example, how does an individual appraise their cognitions when craving-related thoughts are triggered by environmental stimuli that capture attention, and is the individual’s appraisal of their thought processes related to increased craving? Does an attentional bias thwart an individual’s ability to interrupt intrusive thoughts or inhibit them before they occur?

Attentional Bias and Craving

An attentional bias is a partiality in an individual’s cognitive processing towards specific stimuli (Field & Cox, 2008). In the case of craving for substances, the attentional bias is focused on substance related cues and stimuli. It has been hypothesized that a bias in an individual’s attention is due to the importance that the individual attaches to information related to specific stimuli in the environment. To a large extent, attentional biases are viewed as a form of conditioned response related to the pairing of pleasure (i.e., unconditioned stimulus) with the (neutral/conditioned) stimuli. The incentive-sensitization theory (Robinson & Berridge, 1993) holds that, in the case of substance abuse, the pairing of a substance with the pleasure derived from the substance through the dopaminergic system increases motivation to seek out, or attend to, stimuli related to the substance. When stimuli related to the substance are encountered, the dopaminergic pathway is activated leading to the individual’s attention being “captured” by the stimuli. Relatedly, according to the elaborated intrusion theory of desire, a bias in attention towards craving-related stimuli is due to the stimuli triggering the associational processes involving intrusive thoughts and conscious elaboration on the stimuli (Kavanagh, Andrade, & May, 2005). Thus, an attentional bias has the consequence of making an individual more
sensitive to environmental stimuli that can trigger craving, and, in turn, craving-related thoughts can make an individual more likely to search for substance-related stimuli.

Studies on attentional bias in relation to craving and substance use are numerous, and use a variety of tasks to examine such bias (Field, Mufano, & Franken, 2009). The tasks most often used to measure attentional bias in relation to substance use include: the visual probe task, the dual task procedure, and the addiction stroop task. These tasks examine attentional bias by measuring response times related to task performance when substance-related stimuli are presented in relation to neutral stimuli. In the visual probe task, individuals are presented with either a substance-related or neutral stimuli which is then replaced with a probe. Individuals’ responses to the probe are compared between stimuli to highlight an attentional bias. In the dual task procedure, individuals complete a cognitive task while being presented with substance-related or neutral stimuli. Their performance on the cognitive task is compared between stimuli to examine attentional bias. Finally, during the addiction stroop task, individuals are presented with substance-related and neutral words and must report the color that the words are printed in, rather than naming the word itself. Reaction times are compared between the two forms of stimuli to determine attentional bias. There is some controversy over whether individuals who show an attentional bias while completing these task are taking longer to orient to the stimuli or taking longer to disengage from the stimuli (Field et al.). Regardless of whether an individual attends to stimuli quicker, or takes longer to disengage from the stimuli, findings in either case show an attentional bias when a comparison is made with a control group of individuals.

Field, Mufano, & Franken (2009) conducted a meta-analysis of studies examining attentional bias for substance-related stimuli and subjective reports of craving. A total of 68 studies were included in the meta-analysis that explored the relationship between craving and
attentional bias using a variety of attentional bias measures and craving measures. Specific types of attentional bias measures examined in the meta-analysis included the dual task procedure, visual probe task, addiction stroop, event-related potential, and eye-movement gaze duration. A variety of studies using different measures for reporting craving were also examined including studies using a visual analog scale, multiple item self-report scales, and studies using combined visual analog scales and multiple item scales. A significant positive correlation was found between attentional biases and self-reports of craving. Thus, there is significant support for the role of attentional biases in craving for addictive substances.

Further, Field and Cox (2008) reported that there is significant evidence that individuals who meet substance abuse classifications tend to try to suppress substance-related thoughts, and that this tendency is associated with an attentional bias. However, they reported that the findings related to this relationship have been inconsistent due to possible differences in the way that individuals interpret their attentional bias. Specifically, individuals who are trying to avoid a substance, such as those in treatment who are trying to stop substance use, are more likely to use thought suppression. Conversely, young individuals who are not trying to cut down or stop their substance use, or who do not experience substance-related thoughts as distressing, may not use thought suppression to counteract their attentional biases. Little research has examined individuals’ metacognitive intentions related to thought suppression and how this is related to attentional biases. Thus, one of the goals of the current research is to examine this gap in the literature.

Finally, as discussed previously, EI theory predicts that individuals who experience craving-related mental imagery will attempt to suppress the imagery when it becomes distressing (Kavanagh, Andrade, & May, 2005). Very little research to date has examined the relationship
between craving imagery, attentional bias, and thought suppression while taking into account an individual’s appraisal of their metacognitions. This appears to be a limitation in the theory due to the fact that, as stated by Field and Cox (2008), individuals may show differences in attentional bias and thought suppression depending on how they appraise the craving-related thoughts.

Depression, Anxiety, and Craving

One final area that needs to be covered in relation to EI theory involves the role of affect, specifically, anxiety and depression. It has been proposed that negative affect and anxiety are related to increases in craving, and can result in an alteration of the capacity of the cognitive resources that are involved in processing mental imagery and suppressing craving-related thoughts (Kavanagh, Andrade, & May, 2005). As such, it will be important to include these variables in the current study to examine their relationship to the other constructs being explored.

Field and Powell (2007) examined the relationship between stress, craving, and attentional bias in individuals who drink alcohol to cope with their stress. The researchers experimentally manipulated the level of stress in 44 individuals by either exposing them to a stressor, which included telling the individuals they would be required to provide a speech in a few minutes, or putting them in a no-stress control group. Level of anxiety was then measured in all individuals, as well as their level of alcohol craving. Finally, the individuals completed a visual probe task to examine attentional bias. Individuals who engaged in the stress induction task were found to have significantly higher levels of alcohol craving than individuals in the control group. Additionally, individuals who completed the stress induction task, and who reported drinking to cope with stress, had a significantly more pronounced attentional bias.
These results underscore the importance of examining affect in relation to craving and attentional bias as there may be a moderating relationship.

In a similar study, Grant and Stewart (2007) explored the role of mood, which was experimentally-induced using music, on cognitions related to alcohol expectancies. Specifically, individuals who reported drinking alcohol to improve mood, as well as and individuals who reported drinking alcohol to decrease anxiety, completed a measure asking them to report their expectancies related to the effects of alcohol before and after undergoing an anxious or a positive mood induction procedure. Individuals who reported drinking to reduce anxiety, and those who reported drinking to increase mood, were found to experience increased positive cognitions related to the relieving effects of alcohol after experiencing an induced anxious mood state. However, individuals in the induced positive mood state showed no differences in their alcohol expectancies pre- and post- mood induction. As such, it appears that affect is also related to an individual’s beliefs about the effects of alcohol.

Finally, it is important to explore the role of affect in the current study given that it is related to the severity and chronicity of substance abuse. Specifically, Evren, Cetin, Durkaya, and Dalbudak (2010) examined the relationship between relapse six months after treatment and several clinical factors in 107 alcohol dependent males. The males included in the study were examined at baseline and six months after treatment using a structured interview. Individuals who had higher levels of craving, who reported more depressive affect, and who reported more anxiety, were found to be more likely to have relapsed during the six months prior to the second assessment than individuals who reported less pathological levels of these indicators. While there was no experimental manipulation in the study to confirm the role of depressive affect and
anxiety in alcohol relapse, there is still enough evidence to warrant examining these constructs in relation to EI theory.

Role of Family History in Substance Abuse

In addition to examining the role of affect in the current study, another potential moderating variable that is important to account for is family history of substance abuse. Family history of substance abuse has been found to be an important moderating variable in the relationship between substance use and performance on cognitive tasks (Yates, 2011), as well as the relationship between substance use and affect. For example, one study compared individuals with a family history of alcohol abuse against those without a family history of abuse on a go-no/go reaction time task, a test of impulsivity (Saunders, Farag, Vincent, Collins, Sorocco, & Lovallo, 2008). In this study, subjects were broken into groups based on a positive or negative family history of alcoholism, and were then further sub-divided based on personality test scores showing high or low levels of disinhibitory traits. The study found that those who had a positive family history for alcoholism showed more disinhibitory traits than those with a negative family history for alcoholism. Further, the study found that those with a positive family history for alcoholism, as well as higher levels of disinhibition, performed significantly worse on the go-no/go reaction time task. This effect was found only for males involved in the study. The results of this study indicate that males with a family history of alcoholism may have higher levels of disinhibition and impulsivity that could predispose them to risky (impulsive) behaviors including substance abuse.

A second study that examined the role of family history of alcohol abuse on cognition involved a comparison between individuals with a positive family history for alcohol abuse
versus individuals with a negative family history on measures of inhibition related to working memory as well as risk-taking (Lovallo, Yechiam, Sorocco, Vincent, & Collins, 2006). Inhibition was measured in the study using the Stroop Color and Word Test, while risk-taking was measured using the Iowa Gambling Test. The results of the study indicated that the individuals who had a family history of alcohol abuse, and who had problems with behavioral disinhibition, showed poorer inhibition related to working memory. Additionally, males with a positive family history for alcohol abuse, who showed behavioral disinhibition, also showed significantly higher levels of risk-taking.

Because individuals with a positive family history of alcohol abuse, especially males, show cognitive deficits when compared to individuals with a negative family history of alcohol abuse, Pihl, Peterson, and Finn (1990) reviewed the findings of several studies involving the sons of male alcoholics (SOMA’s). Some of the most important findings that they reported, which have been found in several studies using different methodologies included that: SOMA’s have higher levels of attention-deficit/hyperactivity disorder, SOMA’s show hypersensitivity to auditory and visual information, SOMA’s have difficulty regulating emotion and mood, SOMA’s show higher levels of impulsivity, SOMA’s show poorer linguistic ability, and SOMA’s show reduced abstract problem solving ability. Thus, it is apparent that family history is a critical variable to account for when examining cognition, broadly defined, substance use, and craving.

Statement of the Problem

The elaborated intrusion theory of desire (Kavanagh, Andrade, & May, 2005) proposes a cognitive theory of desire that explains craving for substances as the result of intrusive thoughts
that are elaborated upon leading to a dysphoric state through the recognition of a physical or psychological deficit. The theory is based on several findings from previous research related to desire (or craving) including findings from biology, neuropsychology, motivation, conditioning theory, and cognition. One factor believed to be critical to the elaborated intrusion theory of desire is the use of mental imagery in intrusive thoughts as they are elaborated upon.

EI theory makes explicit predictions about several phenomena related to craving including that individuals with high levels of craving will show an attentional bias towards substances, that individuals with high levels of craving will engage in failed thought suppression strategies, that anxiety and depression will be related to craving, and that attention and working memory will be related to the elaboration of craving imagery and intrusive thoughts. Some of these predictions have been examined, but more needs to be done to elucidate the neurocognitive and phenomenological aspects of craving with respect to EI theory. Specifically, are deficits in working memory and attention related to increased cravings, or are working memory and attention merely involved in the process of craving elaboration? Further, what specific component processes of attention and working memory are related to craving? Finally, metacognitive beliefs related to an individual’s appraisal of their ability to use thought control strategies, as well as metacognitions related to the phenomenological aspects of craving, have not been examined fully with respect to what relationship they have with craving intensity.

The goal of the current study was to examine the relationship between cravings for alcohol, craving imagery, affect, thought suppression, attention and working memory, as well as metacognition, in a sample of young adult males to help further articulate EI theory. Additionally, family history of alcohol abuse was examined as a moderator in the relationship between craving elaboration and attention and working memory performance based on findings
of a previous study (Yates, 2011). Additionally, a goal of the current study was to explore predictions derived from EI theory to further clarify the processes involved in craving, especially in light of changes to substance use disorders in the DSM-V which includes craving as a diagnostic criterion for addiction disorders (O’Brien, 2010). There has been little agreement over the construct of craving, thus it is important to work towards a greater consensus to aid in the application of diagnostic criteria. Finally, a greater understanding of craving may aid in the development of novel treatments for addiction disorders, as well as in the application of targeted interventions.

**Operational Definitions**

The specific variables examined in the current study included: craving, craving imagery, metacognitive beliefs, thought suppression, negative alcohol-related metacognitions, problem drinking, family history of alcohol abuse, anxiety, and depression. Additionally, several neurocognitive variables related to attention and working memory were examined including: attentional bias for alcohol-related stimuli, the ability to focus attention, the ability to shift attention, sustained attention, and the ability to encode using attention and working memory.

Alcohol craving was defined using the Obsessive Compulsive Drinking Scale (OCDS; Anton, Moak, & Latham, 1995). Individuals with high levels of alcohol craving were defined as those with a total OCDS score of 7 or greater. Alcohol craving imagery was operationally defined using scores on the Alcohol Craving Experiences Questionnaire (Statham et al., 2011). Specifically, higher scores on items related to the strength and frequency of alcohol craving imagery were used to indicate higher levels of craving imagery. Metacognitive beliefs were defined as total scores on the five factors of the Metacognitions Questionnaire – 30 (Wells &
Cartwright-Hatton, 2004), with higher scores indicating greater endorsement of each factor. Thought suppression was operationally defined as the total score on the White Bear Suppression Inventory for Alcohol-related Thoughts (Hacker, Fehm, Lindenmeyer, & Hoyer, 2002), with higher scores indicating greater use of thought suppression. Negative alcohol-related metacognitions were defined as the sum of item scores for the uncontrollability and thought-action fusion and unpleasantness factors of the Metacognitions Questionnaire for Alcohol Abusers (Hoyer, Hacker, & Lindenmeyer, 2007), with higher scores indicating more negative alcohol-related metacognitions. Problem drinking was defined as the total score on the Alcohol Use Disorders Identification Test (Babor, Higgins-Biddle, Saunders, & Monteiro, 2001). A cut score of 8 was used to define individuals with higher scores as problem drinkers. Family history of alcohol abuse was operationally defined using individuals’ qualitative descriptions of their family history of alcohol abuse on the Family Tree Questionnaire (Mann, Sobell, Sobell, & Sobell, 1985). Individuals who indicated a possible or definite problem drinker in their family history were classified as having a positive family history of alcohol abuse. Anxiety was defined as a continuous score on the trait scale of the State-Trait Inventory for Cognitive and Somatic Anxiety (Ree, MacLeod, French, & Locke, 2000) with higher scores indicating more anxiety. Finally, depression was operationally defined as a continuous score on the Quick Inventory of Depressive Symptomatology – Self Report 16 (Rush et al., 2003) with higher scores indicating a higher level of depressive symptoms.

In regards to the neurocognitive performance variables included in the study, attentional bias for alcohol-related stimuli was defined as the difference in response times between trials on a computerized version of the Alcohol Stroop task using alcohol-related words and household item words with a greater difference in response times indicating attentional bias (Stroop, 1935).
The ability to focus attention was defined as the reaction time on a computerized version of the Trail-Making Test Parts A and B (Reitan, 1958), with greater response times indicating worse performance. The ability to shift attention was defined as the total number of perseverative errors on a computerized version of the Wisconsin Card Sorting Task (Grant & Berg, 1948), with a greater number of errors indicating worse performance. Sustained attention was defined as the value of d-prime (d’) on the Continuous Performance Test – Identical Pairs Version (Cornblatt, Risch, Faris, Friedman, & Erlenmeyer-Kimling, 1988), with higher values for d’ indicating worse performance. Finally, attentional encoding of information into working memory was defined as the total number of correct items on the Paced Auditory Serial Addition Task (Gronwall, 1977), with a higher total score indicating better performance.

Hypotheses

The following hypotheses were made before data collection and are based on predictions derived using EI theory as well as the results of a previous study by Yates (2011):

I. Individuals with high craving will report more intense imagery related to craving than individuals with low craving.

II. Individuals with high craving will report more frequent imagery related to craving than individuals with low craving.

III. Individuals with high craving will be more likely to experience symptoms of anxiety than individuals with low craving.

IV. Individuals with high craving will be more likely to experience symptoms of depression than individuals with low craving.

V. Individuals with high craving will be more likely to use thought suppression than those with low craving.

VI. Individuals with high craving will have a more negative appraisal of their cognition in relation to metacognition than those with low craving.
VII. Individuals with high craving will be more likely to have negative metacognitions related to alcohol than individuals with low craving.

VIII. Individuals reporting higher levels of craving imagery elaboration will show an attentional bias for alcohol-related stimuli in comparison to those reporting lower levels of craving imagery elaboration.

IX. Individuals reporting higher levels of craving imagery elaboration will show worse performance on attention and working memory than individuals reporting lower levels of craving imagery elaboration.

X. The relationship between craving imagery elaboration and performance on attention and working memory will be moderated by family history of alcohol abuse.

XI. Individuals with a more negative appraisal of their metacognitions will show worse performance on attention and working memory.

XII. Negative alcohol metacognitions will positively correlate with attentional bias for alcohol.

XIII. Negative alcohol metacognitions will negatively correlate with performance on attention and working memory.
CHAPTER 2

METHOD

Power Analysis

An *a priori* power analysis was conducted to determine the optimal number of participants required for the current study to achieve a power level of 80%, with an alpha level of .05. The primary statistical analysis planned for the current study was a multivariate analysis of variance (MANOVA) with 2 groups (high and low craving) and 7 response variables (frequency of craving imagery, strength of craving imagery, though suppression, anxiety, depression, metacognitive beliefs, and negative alcohol metacognitions). Since this was the primary analysis proposed for the current study, it was used to determine an adequate sample size given the level of statistical power desired. Based on this analysis, a sample of 66 participants was calculated as the minimum sample size needed to reach statistical significance assuming a moderate effect size of $f^2=.25$. As such, an attempt was made to recruit a minimum of 100 individuals to ensure a sufficient level of statistical power. An attempt was also made to exceed the minimum number of participants needed, to account for any adjustments to alpha or for unplanned analyses that could result from variations in the data. As such, a total of 119 participants were recruited.

Recruitment of Participants

After the current study was approved by the University of North Texas Institutional Review Board (see Appendix A), participants were recruited through the human subjects pool at the University of North Texas. Individuals in this pool agreed to participate in research projects, and were allowed to sign up for studies voluntarily using an internet-based research management program (SONA). Participants were not included in the study if they reported a prior diagnosis of
Attention-Deficit/Hyperactivity Disorder, had been diagnosed with a developmental disorder, or reported currently using psychoactive medications. Participants were initially directed to complete all self-report measures on a secure website utilizing an online survey program. Following the completion of the online survey, participants were given a code to sign up for the second part of the study that involved the administration of the remaining neurocognitive psychological measures. Participants were required to sign up for the second part of the study, and complete it, within 5 days of completing the online survey. All individuals who completed the online survey received 3 credits that could be utilized to fulfill their university research participation requirements. Individuals who completed the second part of the study received an additional 2 credits.

Measures

*Alcohol Stroop*

The alcohol stroop (Alc-Stroop) is a modified research version of the emotional stroop task based on the original Stroop Color and Word Test (Stroop, 1935). Several different versions of the alcohol stroop are available with differing stimuli, scoring, and procedures. The alcohol stroop used in the current study was based on a set of components commonly used in various versions of the alcohol stroop. Specifically, the word lists used in the current study were from Carrigan, Drobes, and Randall (2004). Four separate word lists were developed by Carrigan et al., however, only the alcohol words and household item words were used in the current study, given their relevance to the current study. The alcohol words used included: beer, drunk, party, bar, hangover, liquor, wine, drink, shots, and booze. The household item words used included: dish, brush, table, bag, utensils, screen, sink, frame, sheet, and spoon. The two word lists were
matched on number of letters and frequency of usage in the English language. Both word lists were entered into a word list randomizer to create a randomized list of 100 household item words and a randomized list of 100 mixed household item and alcohol words. The words were presented on a laptop computer using a computerized stroop task program. During the test, three response phases were utilized with each having 100 prompts requiring the participant to press one of three keys indicating “red”, “green”, or “blue”. In the first response phase, the subject was shown the prompt ‘XXXX’ randomized in the different colors (red, green, and blue) and asked to press the key corresponding to the displayed color. In the second response phase, the subject was shown the list of 100 household item words in capital letters, randomized in the different colors, and asked to press the key corresponding to the displayed color. Finally, in the third response phase, the subject was shown the list of mixed household item and alcohol words and asked to press the key corresponding to the displayed color. Each word was presented on a blank screen, and remained on screen, until the participant pressed the correct color key. The average response time was recorded for each subset of words (XXXX, household item, and mixed household item and alcohol). Consistent with Ryan (2002), the response time for the mixed household item and alcohol words list was compared to the response time for the household item words list. An interference index was calculated by subtracting the mean response time for household item words from the mean response time for the mixed household item and alcohol words. The alcohol stroop task is a widely used measure of attentional bias for alcohol-related stimuli, however, little consensus has been reached in regards to the best methodology for its presentation (Field, Mufano, & Franken, 2009). The presentation used in this study was consistent with that used in a majority of prior studies.
The Continuous Performance Test – Identical Pairs Version (CPT-IP), (Cornblatt, Risch, Faris, Friedman, & Erlenmeyer-Kimling, 1988) is a computerized continuous performance task that measures sustained attention. It was presented on a laptop computer. The CPT-IP has 10 different configurations that can be used, however, only one of the default configurations was used for the current study. This configuration presented the subject with 150 different trials where the stimulus was displayed for 50 msec, followed by 950 msec. of a blank screen. In the configuration chosen for this study, the subject was presented with random four digit numbers. The subject was required to lift their finger off of a button on a computer mouse each time they recognized two stimuli in a row that were identical. Over the course of the presentation of the stimuli, 20% were truly identical, 20% were nearly identical but wrong, and 60% were clearly wrong. The value of $d'$, a measure of signal detection, was used to examine sustained attention, with higher numbers indicating a better performance. The CPT-IP has been found to have good reliability and validity with a test-retest coefficient of .84 (Nuechterlein et al., in press).

The Trail-making Test part A and B (TRAILS-A & TRAILS-B) is a computerized research version of the original trail-making test by Reitan (1958). The test was administered on a laptop computer using a research software package (Mueller, 2008). During the test, participants were required to connect 25 dots on the computer screen with the mouse by clicking on the dots in sequential order. During the first part of the test (part A), participants were required to click the dots in numerical order from 1 through 25. During the second part of the test (part B), participants were required to click the dots in order alternating between numbers and
letters (i.e. 1, A, 2, B, etc.). The length of time taken to complete each portion of the test, as well as the number of errors made, was recorded. The total reaction times for each part (A and B) on the trail-making test were used in the current study as a measure of the participants’ attention focusing ability.

**Wisconsin Card Sorting Test**

A computerized research version of the Wisconsin Card Sorting Test (WCST; Grant & Berg, 1948) was used to measure mental set shifting and flexibility. The test was administered using a research software package on a laptop computer (Mueller, 2008). During the test, subjects were presented with trials involving 80 stimulus cards that were matched to 4 target cards. The target cards, which appeared fixed at the top of the computer screen, included a card with a single red circle, a card with two green stars, a card with three blue squares, and a card with four yellow plus symbols. The stimulus cards, which appeared one after the other in the bottom right corner of the screen, used similar symbols and colors, which were varied to create combinations with each type of symbol, number of symbols, and color of symbols. The respondent was required to match the stimulus card with the target cards based on unknown, randomized, rules. In order to match the stimulus card with the target card, the respondent was asked to press the number key on a keyboard, which corresponded to one of the four target cards. After completing all trials, the program calculated the number of perseverative errors made over the course of all trials. These scores were used as a measure of mental set shifting and flexibility with higher numbers of perseverative errors indicating poorer shifting ability. The Wisconsin Card Sorting Test is a widely used and valid measure of mental set shifting; however, it has been found to have poor test-retest and alternate-form reliability (Bowden et al., 1998).
Paced Auditory Serial Addition Test

The Paced Auditory Serial Addition Test (PASAT) was used to measure sustained attention and encoding of information into working memory. The PASAT is a computerized research version of the Paced Auditory Serial Attention Test developed by Gronwall (1977). During the test, participants listened to a series of numbers through an audio recording played on a laptop computer. The audio recording included four sets of 50 numbers with varying time intervals between numbers of 2.4, 2.0, 1.6, and 1.2 seconds respectively. The participant was asked to listen to the series of numbers and add consecutive pairs of numbers. The participant was then asked to report the sum for each pair, and this was recorded on a form by the individual administering the test. The PASAT has shown a high level of validity in identifying individuals with brain injury and correlates highly with the working memory factor of the WAIS-R (Gronwall & Wrightson, 1974). Further, the PASAT has been shown to be reliable with split-half reliability of .96 (Egan, 1988) and test-retest reliability of .77 to .90 on various computerized versions of the test (Carney, 2007). The total number of correct responses on the test was used as a measure of attentional encoding and working memory in the current study.

Alcohol Craving Experience Questionnaire

The Alcohol Craving Experience Questionnaire (ACE) is a 29 item self-report scale measuring sensory aspects of craving, as well as alcohol-related thoughts (Statham et al., 2011). The scale was designed specifically to test hypotheses related to the elaborated intrusion theory of desire (Kavanagh, Andrade, & May, 2005). Specifically, the scale examines aspects of desire-related mental imagery, sensory experiences, and the strength and frequency of desire-related thoughts. The scale includes 29 questions that are scored using a visual analog scale with anchor
points of 0 (not at all) and 10 (extremely or constantly). The visual analog scale designed for the current study was scored using a computer program whereby the subject was asked to check a button next to their desired response. The Alcohol Craving Experience Questionnaire has been found to have a three-factor structure including factors corresponding to imagery, intensity of desire, and intrusive thoughts related to desire (Statham et al., 2011). The Alcohol Craving Experience Questionnaire has been found to have good validity and reliability with internal reliability coefficients ranging from .74 to .94.

**Obsessive Compulsive Drinking Scale**

The Obsessive Compulsive Drinking Scale (ODCS; Anton, Moak, & Latham, 1995) is a 14 item self-report scale measuring alcohol-related thoughts. This scale was designed as a measure of alcohol craving and focuses on the obsessive thoughts related to alcohol rumination. Additionally, the scale measures compulsions, as well as, the amount and frequency that a person drinks. Questions 1-6 of the Obsessive Compulsive Drinking Scale measure alcohol obsessions, while questions 7-14 of the scale measure alcohol compulsions. A cutoff score of 7 has been shown to reliably differentiate individuals with an alcoholic level of craving, and it was reported by Anton et al. that little is gained using separate scale scores for the two portions of the measure. This scale was chosen to quantify the amount of craving individuals experience on a global basis over a period of several weeks. This scale measures craving in a manner similar to measures of Obsessive Compulsive Disorder. It has been shown to have good reliability and validity with a test-retest coefficient of .96.
**Alcohol Use Disorders Identification Test**

The Alcohol Use Disorders Identification Test (AUDIT; Babor, Higgins-Biddle, Saunders, & Monteiro, 2001) is a 10 item self-report scale designed as a screening test for alcohol use disorders. The test uses a likert-type scale for each question with scores ranging from 0 to 4. The highest attainable score on the Alcohol Use Disorders Identification Test is 40, and the lowest score is 0. The test measures the level of disordered drinking, or alcohol-related problematic behaviors, that a person engages in on average, and uses this information to label drinkers as potentially having an alcohol use disorder. A cutoff score of 8 is commonly used to identify individuals with an alcohol use disorder. The Alcohol Use Disorders Identification Test is a widely used measure and has good reliability and validity with internal consistency coefficients ranging from .75 to .97. This test was used to classify participants as having an alcohol use disorder. The cutoff score was used for descriptive purposes to describe the overall stratification of the sample.

**Family Tree Questionnaire**

The Family Tree Questionnaire (FTQ; Mann, Sobell, Sobell, & Sobell, 1985) is a brief self-report instrument designed to gather information about an individual’s family history of alcohol use. Individuals were presented with a graphical portrayal of their family tree including their parents, grandparents, brothers, and sisters. Individuals were asked to rank each family member on their history of alcohol use using one of six descriptors including: never drank, social drinker, possible problem drinker, definite problem drinker, no relative, or don’t know or remember. Based on the information presented by the individual, a qualitative determination was made on whether or not the individual should be classified as having a positive family history of
alcohol abuse or not. Using liberal criteria, participants were determined to have a positive family history of alcohol abuse if any of their relatives were described as a possible problem drinker or a definite problem drinker. The liberal criteria were used in the current study to provide a higher level of sensitivity while still maintaining adequate specificity. Previous studies have indicated that the test-retest reliability of the Family Tree Questionnaire is good with coefficients ranging from .78 to .94 (Hodgins & Shimp, 1995).

**White Bear Suppression Inventory for Alcohol Related Thoughts**

The White Bear Suppression Inventory for Alcohol-related Thoughts (WBSI-AT; Hacker, Fehm, Lindenmeyer, & Hoyer, 2002) is a 15-item scale that measures the tendency to suppress thoughts related to alcohol. The WBSI-AT is an alternate version of the original White Bear Suppression Inventory (Wegner & Zanakos, 1994), which measures the tendency to use thought suppression without regard to the content of the thoughts being suppressed. The WBSI-AT has been found to be a reliable and valid measure of thought suppression, and has shown high internal consistency with a Cronbach’s α of .93 (Hacker et al., 2002). The WBSI-AT uses a 5-point likert-type scale for each question with scores ranging from 1 to 5. Higher scores on the WBSI-AT indicate a higher propensity to engage in thought suppression of alcohol-related thoughts.

**Metacognitions Questionnaire – 30**

The Metacognitions Questionnaire – 30 (MCQ-30; Wells & Cartwright-Hatton, 2004) is a 30-item self-report short form of the 65-item Metacognitions Questionnaire (Cartwright-Hatton & Wells, 1997). The MCQ-30 was designed to measure aspects of metacognition related to
metacognitive beliefs, confidence in metacognitions, and monitoring of metacognitions (Wells & Cartwright-Hatton). The MCQ-30 has a 5 factor structure with factors measuring components of metacognition related to psychological disorders including: cognitive confidence, positive beliefs about worry, negative beliefs about thoughts concerning uncontrollability and danger, negative beliefs concerning the consequences of not controlling thoughts, and cognitive self-consciousness. The MCQ-30 used in the current study included a 4-point likert-type scale for each question with scores ranging from 1 to 4. Scores for the individual factors were used to indicate usage of each of the components of metacognition measured by the overall scale with higher scores indicating higher levels of endorsement of each factor.

*Metacognition Questionnaire for Alcohol Abusers*

The Metacognition Questionnaire for Alcohol Abusers (MCQ-A; Hoyer, Hacker, & Lindenmeyer, 2007) is a 21-item scale designed to measure alcohol-specific metacognitions in individuals who abuse alcohol. Three factors are measured by the MCQ-A including: uncontrollability and thought-action fusion, unpleasantness, and subjective utility of the thought. Research has shown that the first two factors, uncontrollability and thought-action fusion and unpleasantness, measure negative appraisal of alcohol-related metacognitions. The third factor may be a more useful measure of aspects of alcohol-related metacognitions that serve to protect an individual while experiencing alcohol-related metacognitions. The MCQ-A has been found to be a valid and reliable measure of alcohol metacognitions with internal consistency coefficients ranging from .85 to .91 (Hoyer et al.). The MCQ-A uses a 5-point likert-type scale for each question with scores ranging from 1 to 5. For the current study, only the uncontrollability and thought-action fusion factor, as well as the unpleasantness factor, were used. Specifically, the
sum total score for these two factors was used to indicate the level of negative metacognitions participants have related to alcohol.

**State-Trait Inventory for Cognitive and Somatic Anxiety**

The State-Trait Inventory for Cognitive and Somatic Anxiety (STICSA; Ree, MacLeod, French, & Locke, 2000) is a 42-item self-report scale designed to measure cognitive and somatic symptoms of anxiety (Gros, Antony, Simms, & McCabe, 2007). The STICSA has two subscales with one subscale (21 items) measuring state anxiety, and one subscale (21 items) measuring trait anxiety. Each subscale uses a 4-point likert-type scale to rate the frequency or applicability of symptoms with 1 being equivalent to not at all and 4 being equivalent to very much so. The STICSA has been found to have good reliability and validity with internal consistency coefficients ranging from .87 to .88. For the current study, the trait subscale of the STICSA was used to examine overall anxiety symptoms over a period of time with higher scores indicating more anxiety.

**Quick Inventory of Depressive Symptomatology – Self Report 16**

The Quick Inventory of Depressive Symptomatology – Self Report 16 (QIDS-SR16; Rush et al., 2003), is a 16-item self-report measure of depression symptoms. The questionnaire asks questions related to sleep, appetite, weight, energy, and cognitive aspects of depression. Answers on the QIDS-SR16 receive a score of 0 to 3 points with higher scores indicating higher endorsement of each symptom. The total score on the QIDS-SR16 has been found to be a reliable and valid measure of depressive symptomatology with internal consistency coefficients ranging from .81 to .86 (Rush et al.).
Procedure

This was a two-part study. During the first part of the study, individuals completed all self-report measures on a secure website after signing up to participate in the study through the University of North Texas research participants’ pool SONA system. Individuals were then given a code number to sign up for the second part of the study and were asked to sign up for the second part, and complete it, within 5 days of finishing part one. Individuals then completed the remaining measures of the study in the Personality and Neurocognition Laboratory at the University of North Texas. All data were entered into a statistical software package for statistical analysis. Individuals who participated in the study signed an informed consent form before participation (see Appendix A) and were given the opportunity to ask questions related to their participation. Additionally, all participants were verbally debriefed upon completion of the study if they participated in part 2 of the study, or they were debriefed through a written statement on a secure website if they only completed part 1 of the study. All participants were given the option of ending their participation in the study at any time without penalty.

Data Analysis

After all data were entered into a statistical software package for analysis, two types of missing data were identified. Missing data present a problem for research due to the loss of statistical power created, and the limitations that missing data impose on the types of statistical analyses that can be used to examine the data. There are three possible types of missing data (Graham, 2009), data that are: missing completely at random (MCAR), missing at random (MAR), and missing not at random (MNAR). Data that are MCAR do not depend on the unobserved or observed data, and cases with data that are MCAR represent a random sample of
all cases in the data set. Data that are MAR depend on the observed data but not the unobserved data. Finally, with data that are MNAR, the missing data depend on both the observed and unobserved data, and may be related to a characteristic of the participant.

As stated before, two types of missing data were identified in the current study. Of the 119 subjects who participated in the study, 43 participants (36.1%) did not complete the second part of the study involving the administration of the computerized attention and working memory measures. Thus, the attention and working memory test data for these individuals was considered to be MNAR data. Descriptive statistics are provided to explore any differences between these individuals and those who completed the entire study in the results section. The second type of missing data involved in the study were missing data points on the attention and working memory measures for those 76 individuals (63.9%) who completed both parts of the study. These data were missing due to random computer error, and was thus considered to be MCAR data. For this data, a missing data analysis was conducted using the statistical software package. Little’s MCAR test confirmed that the data missing for the 76 individuals who completed all measures in the study were missing completely at random. A total of 43 data points were missing for these individuals.

Because the data were determined to be MCAR, maximum likelihood estimation was used to estimate the missing data points using the expectation-maximization algorithm. This technique has been used in the past with similar cognitive variables (Salthouse & Davis, 2006) to estimate missing data points. Sterner (2011), and Baraldi and Enders (2009), recommended maximum likelihood estimation as a modern method to derive estimates for missing data points as an alternative to other less powerful or potentially misleading methods such as pairwise deletion, listwise deletion, mean substitution, or other single imputation methods. A summary of
the data from the missing data analysis is provided in Table 7 with the mean and standard deviation for all variables with missing data points, as well as the data with points estimated using the maximum likelihood estimation procedure. Additionally, a summary of the frequency of missing data is provided for each variable with missing data points.

Because only 76 participants completed all measures involved in the study, analyses that examined hypotheses related to the attention and working memory measures were conducted separately from other analyses, which could make use of the entire sample of 119 individuals. Finally, there were no significantly different correlations among variables with data estimated using maximum likelihood estimation and variables using only the originally observed data. As such, all tables and analyses in the current study made use of the full data with data points estimated using maximum likelihood estimation via the expectation-maximization algorithm when possible.

To explore the hypotheses in the study, a combination of statistical tests were used. To explore hypotheses I, II, III, IV, V, VI, and VII a multivariate analysis of variance was used and included all 119 participants. To explore hypotheses VIII, IX, and X multiple linear regression was used, and involved only the 79 participants who completed both parts of the study. Finally, to explore hypotheses XI, XII, and XIII, the correlations between variables were examined for those individuals who completed both parts of the study (n=79). Because all hypotheses examined in the current study were a priori directional hypotheses, one-tailed tests were used. Finally, to provide moderate protection against type I error, statistical significance was defined as $p < .01$, except for analyses exploring the assumptions of the statistical tests used, which used accepted conventions. Additionally, tables in the appendix showing correlation coefficients were two-tailed tests and provide significance at $p < .05$ and $p < .01$ for descriptive purposes.
However, all hypotheses were either accepted or rejected based on \( p < .01 \). This method was used to preserve power as opposed to the Bonferroni correction, and sufficient information is provided to evaluate the results using more stringent criteria should the reader desire. All results are clearly labeled by the criteria used to determine significance.
CHAPTER 3

RESULTS

Descriptive Statistics

Participants

A total of 119 young adult males aged 16 to 31 ($M = 20.98; SD = 2.636$) participated in the study. A breakdown of participants by ethnicity including the frequency and percentage of individuals from each ethnic group, as well as the frequency and percentage of individuals in each ethnic group classified as having levels of alcohol craving consistent with significant alcohol abuse or considered to be problem drinkers is provided in Table 1. Of note, approximately half, 50.4%, of the participants were classified as Caucasian ($n = 60$), with the rest of the sample composed of individuals from other ethnic groups. The frequency and percentage of individuals reporting a history of head injury, alcohol use, drug use other than alcohol, and a family history of alcohol abuse is provided in Table 2. Individuals with a history of head injury or drug use other than alcohol were included in the sample, even though alcohol use and craving for alcohol were the focus of this study, due to the high comorbidity of injury and other drug use with alcohol use. A limited number of individuals reported a previous head injury causing unconsciousness ($n = 10; 8.4\%$) and/or other drug use ($n = 26; 21.8\%$).

Participants who reported drinking alcohol indicated that they first began drinking between age 12 and 23 ($M = 17.23; SD = 2.147$). Additionally, individuals who reported drinking alcohol indicated that on the typical week they consumed between 0 and 30 drinks ($M = 3.99; SD = 5.671$). One drink was defined as 12 fl. oz. of beer, 8-9 fl. oz. of malt liquor, 5 fl. oz. of table wine, or a 1.5 fl. oz. shot of 80 proof liquor. Individuals differed significantly with respect to craving on number of drinks per week with individuals classified as having high levels of
craving reporting significantly more drinks per week ($M = 6.29; SD = 7.002$) than individuals classified as having low craving levels ($M = 2.99; SD = 4.693$), $t(117) = -2.585, p < .01$, two-tailed, equal variances not assumed. Finally, 28 participants reported that they used to drink alcohol, but have stopped for health or other reasons. Of these individuals, the mean length of abstinence from alcohol was 66.18 days ($SD = 147.594$). The longest period of abstinence from alcohol reported at the time the study was completed was 730 days with the lowest number reported being 1 day. The median number of days of abstinence reported was 14 days.

As mentioned before, out of the 119 participants who completed the study, only 76 individuals completed both parts of the study including the attention and working memory measures. Data points for individuals who did not complete the attention and working memory measures were considered to be not missing at random. Individuals who did not complete the entire study did not differ from those who did complete the study on the basis of OCDS score, AUDIT score, age, age at first drink, number of drinks per week, number of family members classified as problem drinkers, QIDS score, STICSA score, MCQ-30 score, MCQ-A score, WBSI-AT score, or ACE score (means and standard deviations provided in Table 3). While the individuals did not differ on these measures significantly, it is impossible to know how they might have differed with respect to the attention and working memory measures, and thus, those data points were considered not missing at random. As a consequence, individuals who did not complete the attention and working memory measures could not be included in analyses using those measures.

**Measures**

Descriptive statistics are provided for all measures involved in the study including:
measures of alcohol use and craving (Table 4), measures of metacognition (Table 5), measures of anxiety and depression (Table 6), and measures of attention and working memory (Table 8). Descriptive statistics provided for each measure include the mean, standard deviation, skewness, kurtosis, Cronbach’s $\alpha$, and the mean inter-item correlation. The data from each measure were examined for normality, and the need for data transformations to achieve normality, via skewness and kurtosis. Specifically, each measure was determined to be approximately normal if skewness and kurtosis values were within +/- 3. All measures were determined to be approximately normal, and no data transformations were required. For self-report measures, Cronbach’s $\alpha$ and the mean inter-item correlations indicated that all scales were internally consistent and had adequate item homogeneity except for the QIDS which may not be unidimensional. The QIDS is nonetheless regarded as a good overall indication of depressive symptomatology. The alcohol-related measures including the ACE, AUDIT, and OCDS were strongly inter-correlated with correlation coefficients ranging from .443 to .984. Finally, a summary of the means and standard deviations for the individual components of the alcohol stroop test are provided in Table 10.

To examine the relationship between the attention and working memory measures, Pearson product-moment correlation coefficients were calculated between each test. Table 9 includes a summary of the correlations between those variables. As expected, the alcohol stroop task was not significantly correlated with any of the other attention and working memory measures as it is not a pure measure of attention deficit, rather a measure of attentional bias. All other attention and working memory measures were significantly correlated in the expected direction, except for the CPT-IP and the WCST.
Finally, the correlations among all of the variables used in the study are provided in Tables 11 through 17. Significant correlations between variables were shown at the $p < .05$ and $p < .01$ level for descriptive purposes. Additionally, the correlations among variables were useful in exploring the assumptions of statistical tests used to evaluate the hypotheses, and these assumptions will be discussed in further detail later.

**Inferential Statistics**

*Mental Imagery, Emotional Functioning, and Metacognition*

In order to test hypotheses I through VII, a one-way multivariate analysis of variance (MANOVA) was used. Hypotheses I through VII, were predictions derived from EI theory. Thus, an exploration of differences between individuals with craving consistent with significant alcohol abuse and those with low alcohol craving on the dependent variables was appropriate. A person-centered approach was used as opposed to a variable-centered approach due to its clinical utility in working with individuals. The dependent variables examined using MANOVA included: the QIDS, STICSA, WBSI-AT, MCQ-A, the five factor scores of the MCQ-30, and the strength and frequency of craving imagery scores of the ACE.

Before conducting the MANOVA, the statistical assumptions of the test were examined. First, the sample size was large enough to conduct the analysis, given 119 individuals were included with 36 participants in the high craving group and 83 participants in the low craving group. Second, normality was assessed via an examination of the skewness and kurtosis of each variable included in the analysis. All variables were approximately normal, and appeared to have a normal distribution via examination of histograms with a normal curve superimposed. Additionally, because of the sample size in each cell, the MANOVA was robust to any violations
of normality. Third, the variables included in the analysis were examined for outliers using box plots and via the calculation of Mahalanobis’ distance. Mahalanobis’ distance values ranged from 2.185 to 38.993. The critical value for determining multivariate outliers was $\chi^2 = 31.26, p < .001$. Only two Mahalanobis’ distance scores were slightly above the critical value, and as such, the analysis was determined to be robust to these outliers. Fourth, the dependent variables were assessed for linearity via bivariate correlations and a scatterplot matrix for each level of the independent variable (high vs. low craving). Linearity was found between most variables, though MANOVA is robust to small deviations in linearity. Sixth, most of the dependent variables were moderately correlated, and thus there did not appear to be a problem with multicollinearity. Sixth, homogeneity of variance-covariance matrices (homoscedasticity) was assessed with Box’ $M$ and this assumptions was not violated, Box’s $M = 77.098, F(66, 15841.315) = 1.029, p = .432$. Seventh, the homogeneity of error variances was assessed for each of the dependent variables using Levene’s test of equality of error variances. None of the dependent variables violated this assumption except for the two factor scores of the ACE. Again, however, univariate ANOVAs are normally robust to violations of this assumption.

After examining the assumptions, the one-way MANOVA was conducted and a significant MANOVA effect was obtained, Wilks’ Lambda = .726, $F(11, 107) = 3.673, p < .001$. The multivariate effect size was estimated at $\eta^2_p = .274$. This indicates that 27.4% of the canonically derived dependent variable was accounted for by level of alcohol craving. Following the MANOVA, a series of univariate one-way ANOVAs were conducted to examine the effect of craving on each of the dependent variables. As can be seen in Table 18, six of the ANOVAS showed a significant effect for craving on the dependent variables at $p < .01$. Specifically, STICSA scores, WBSI-AT scores, MCQ-30 Self scores, MCQ-30 Need scores, ACE-S Img
scores, and ACE-F Img scores were significantly higher for individuals reporting alcohol craving consistent with significant alcohol abuse in comparison with individuals with low levels of alcohol craving. Additionally, the ANOVAs showed that differences between the craving groups on QIDS scores, MCQ-A scores, and MCQ-30 Unc scores approached statistical significance. No significant differences were found between groups on MCQ-30 Cog scores, or MCQ-30 Pos scores.

Attention and Working Memory

In order to test hypotheses VIII, IX, and X hierarchical multiple regression was used. Hypotheses VIII, IX, and X concerned the relationship between performance on attention and working memory, as well as attentional bias for alcohol-related stimuli, with craving-related mental imagery elaboration. The dependent variable used to examine these hypotheses was the total score for the ACE, a measure of the strength and frequency with which an individual experiences craving-related mental imagery and intrusive thoughts related to alcohol. The independent/predictor variables used to examine these hypotheses included the: CPT-IP, WCST, TRAILS-A, TRAILS-B, PASAT, and Alc-Stroop. Additionally, the classification of individuals as either having a positive or negative family history (FH) of alcohol abuse, based on the Family Tree Questionnaire, was explored as a moderator in the relationship between attention/working memory and craving-related imagery elaboration for alcohol. As such, scores for the CPT-IP, WCST, TRAILS-A, TRAILS-B, PASAT, and Alc-Stroop were mean-centered. An interaction term was then created for each predictor with FH status by calculating the product of each attention/working memory variable and FH status.
Before conducting the hierarchical multiple regression analysis, the statistical assumptions of multiple regression were explored with respect to the data. First, the assumption of linearity between the independent and dependent variables was examined via a scatterplot of the regression standardized residuals versus the standardized predicted values. The values were symmetrically distributed around the center indicating that this assumption was not violated. Second, the assumption of the normality of the variables was examined via the skewness and kurtosis of each variable. All variables involved in the analysis were within +/- 3 indicating that they were approximately normal. Additionally, a histogram with the frequency of the regression standardized residuals was examined and the standardized residuals were normally distributed. Third, the assumption of homoscedasticity was examined through examination of the scatterplot of standardized residuals versus the standardized predicted values. Again, the values were symmetrically distributed indicating that this assumption was not violated.

Following an examination of the assumptions of multiple linear regression, the hierarchical regression analysis was conducted. As can be seen in Table 19, the centered attention and working memory variables, as well as the dichotomous FH variable were entered in block one of the regression. Next, the interaction terms for each of the attention and working memory measures with FH were entered into block two of the regression. The first model with the attention and working memory variables and FH was not statistically significant, $F(7, 68) = 1.079, p = .386$. Additionally, the second model with the interaction terms entered was not significant, $F(7, 68) = 1.076, p = .396$. The beta weights, significance levels for each of the predictors, $t$ statistics, and adj. $R^2$ values are provided in Table 19 for each model examined. Finally, there was no significant change on the variance accounted for by the second model, $F(6, 62) = 1.064, p = .394$, two-tailed.
Metacognition and Attention

To explore hypotheses XI, XII, and XIII the correlation coefficients for each of the variable relationships predicted by the hypotheses were examined. To explore hypothesis XI, the attention and working memory measures were correlated with each of the five factors of the MCQ-30. Hypothesis XI was that attention and working memory would correlate with a more negative appraisal of metacognition. None of the attention and working memory measures were significantly correlated with any of the five factors of the MCQ-30 (see Table 15). To explore hypothesis XII (negative alcohol metacognitions will positively correlate with attentional bias for alcohol), a Pearson product-moment correlation coefficient was calculated for the Alc-Stroop with the MCQ-A. The Alc-Stroop and MCQ-A did not significantly correlate, \( r(76) = .074, p = .263 \). Finally, to explore hypothesis XIII (negative alcohol metacognitions will negatively correlate with attention and working memory performance), Pearson product-moment correlation coefficients were calculated for the MCQ-A with the attention and working memory measures. Again, no significant correlations were found (see Table 15). Additionally, none of the correlations examined in hypotheses XI, XII, and XIII were significant when accounting for family history of alcohol abuse.

Exploratory Analyses

Craving Model and EI Theory

Because of the smaller sample size for individuals who completed the attention and working memory measures, it was important to evaluate some of the hypotheses related to these measures separately to increase power for analyses that could make use of a larger sample size. However, as an exploratory analysis, a hierarchical multiple regression was conducted to
examine the relationships between all of the variables involved in the study with craving. Family history of alcohol abuse (FH), sustained attention (CPT-IP), and attentional bias for alcohol-related stimuli (Alc-Stroop) were included in block one of the hierarchical multiple regression analysis. This was done as these variables are related to genetic or neurological/neuropsychological processes. The CPT-IP was chose to represent overall attention performance as it was the most significant predictor in earlier analysis. Additionally, the number of variables used in the exploratory analysis had to be limited to increase power. In the second block, all of the emotional functioning and metacognition variables were entered including: MCQ-30 score, MCQ-A score, WBSI-AT score, STICSA score, and QIDS score. Finally, in the third block, the two imagery factor scores (ACE-S Img= craving imagery strength; ACE-F Img= craving imagery frequency) and the two thought intrusion factor scores (ACE-S Int = craving thought intrusion strength; ACE-F = craving thought intrusion frequency) of the ACE were entered. These variables were entered in the last block to evaluate the independent contribution of alcohol-related mental imagery and thought intrusions to the prediction of craving. Unlike the earlier analyses of the *a-priori* directional hypotheses, two-tailed statistics were used.

As with the earlier hierarchical multiple regression analysis, the statistical assumptions of multiple regression were examined. The assumption of linearity between the independent and dependent variables was examined via a scatterplot of the regression standardized residuals vs the standardized predicted values. The assumption was not violated as the residual values were symmetrically distributed. The assumption of normality of the variable was examined via skewness and kurtosis and all variables were approximately normal. A histogram of the regression standardized residuals was also approximately normal. Finally, the assumption of homoscedasticity was examined via the scatterplot of standardized residuals versus the
standardized predicted values. The values were symmetrically distributed showing that the assumption of homoscedasticity was not violated.

Following the examination of the assumptions, the hierarchical multiple regression was conducted. Model 1, which included the attention and family history variables, was not statistically significant at \( p < .01 \). However, the model approached significance, \( F(3, 72) = 2.973, p = .037 \), two-tailed (see Table 20 for beta weights of each of the predictor variables). None of the individual predictors were statistically significant for Model 1.

Model 2, which included the addition of the emotional functioning and metacognition variables, was statistically significant, \( F(8, 67) = 3.759, p = .001 \), two-tailed (see Table 20). Model 2 accounted for 31\% of the variance in craving score (\( R^2 = .310; \text{adj. } R^2 = .227 \)). Higher level of anxiety (STICSA score) was the only statistically significant predictor in Model 2 (\( t = 2.799, p = .007 \), two-tailed). The change in \( R^2 \) from Model 1 was statistically significant, \( F(5, 67) = 3.875, p = .004 \), two-tailed. The second model accounted for an additional 20\% of the variance in craving over Model 1.

Finally, Model 3, which included the strength and frequency of alcohol craving-related mental imagery and thought intrusion variables was statistically significant, \( F(12, 63) = 5.842, p < .001 \), two-tailed (see Table 20). Model 3 accounted for 52.7\% of the variance in craving score (\( R^2 = .527; \text{adj. } R^2 = .437 \)). Neither the strength of craving imagery (ACE-S Img), \( t = .957, p = .342 \), two-tailed, nor the frequency of craving imagery (ACE-F Img), \( t = .450, p = .654 \), two-tailed, significantly predicted craving. The frequency of craving-related thought intrusions (ACE-F Int) was also not a significant predictor of craving, \( t = -1.831, p = .072 \), two-tailed. However, the strength of craving-related thought intrusions (ACE-S Int) did significantly predict craving, \( t = 3.262, p = .002 \), two-tailed. Higher anxiety (STICSA score) was also a significant
predictor in Model 3, \( t = 2.945, p = .005 \), two-tailed. The change in \( R^2 \) for Model 3 over Model 2 was also statistically significant, \( F(4, 63) = 7.216, p < .001 \), two-tailed. Model 3 accounted for an additional 21.7% of the variance in craving score over Model 2.
CHAPTER 4
DISCUSSION

The overall goal for the current study was to examine several hypotheses derived from the elaborated intrusion theory of desire (Kavanagh, Andrade, & May, 2005). The elaborated intrusion theory of desire (EI theory) is a cognitive model of desire that views craving for illicit substances as an extreme form of desire. EI theory attempts to explain findings from multiple areas of research related to craving through an emphasis on mental imagery as a key component of the cognitive processes involved in craving. According to EI theory, craving involves intrusive thoughts that burst into awareness through a non-conscious process of thought association (Andrad, May, & Kavanagh, 2009). Once conscious, attention and working memory are captured, and elaboration on the intrusive thought occurs through the use of mental imagery. This process involves affect in that mental imagery is typically emotionally linked. Additionally, the experience of the elaboration of mental imagery or intrusive thoughts may be viewed as pleasurable by an individual, at least initially, or could cause a dysphoric state through the physical or mental consequences of desires that are not met. Further, individuals who try to suppress the thoughts or images related to craving may struggle to do so by using failed thought suppression strategies. Research has found that thought suppression is particularly difficult with emotionally laden cognitions (Behar, Vescio, & Borkovec, 2005). According to EI theory, cues in the environment, emotional states, physiological states, anticipatory responses, or substance-related cognitions can trigger the thought intrusion and elaboration process leading to desire or craving.

While many of the proposed processes of EI theory have received considerable research attention (Andrade, May, & Kavanagh, 2009; Berry, Andrade, & May, 2005; Berry, Andrade, &
Kavanagh, 2010; Kavanagh, Andrade, & May, 2005; Kavanagh, May & Andrade, 2009; May, Andrade, Panabokke, & Kavanagh, 2010), questions still remain. Specifically, questions about the role of attention and working memory in the processing of craving imagery and craving-related intrusive thoughts have not been answered fully with regard to whether differential performance in these cognitive domains is related to craving. Additionally, the role of family history as a moderator in the relationship between neurocognitive performance and craving has not been fully examined. Yates (2011) found that family history of alcohol abuse served as a moderator in the relationship between sustained attention and craving for alcohol in a sample of young adult males and females. However, this relationship has not been examined with respect to craving-related mental imagery elaboration.

Additionally, much is known about the obsessive-compulsive nature of craving (Anton, Moak, & Latham, 1995; Anton, 1999), however, the phenomenological aspects of craving obsessions have not been fully explored. Specifically, how does an individual’s appraisal of their thoughts related to craving, especially in light of EI theory which argues for the importance of craving imagery and the elaboration of craving-related thoughts and images, affect the experience and strength of cravings? Is it possible that failed metacognitive strategies used to control cravings or negative metacognitive appraisals are related to increased craving? The current study attempted to answer these questions in order to expand on both EI theory and craving, or substance abuse literature, in general.

Evaluation of Hypotheses

Hypotheses I through VII were tested using a multivariate analysis of variance (MANOVA). This statistical test was chosen to test these hypotheses as the hypotheses were
related to group differences in individuals with high versus low craving. High craving was defined as a score of 7 or higher on the Obsessive Compulsive Drinking Scale, with low craving being a score of 6 or lower. Additionally, all of the dependent variables under consideration for these hypotheses were interval/ratio data. As such, MANOVA was used to increase power while also controlling the type I error rate. The omnibus statistic for the MANOVA was statistically significant, and thus, interpretation of the differences for each of the independent variables was conducted.

The first hypothesis examined was that individuals with higher craving would report more intense imagery related to alcohol than individuals with lower craving. This hypothesis was related to one of the key assumptions of EI theory that craving-related mental imagery is at the center of the craving elaboration process (Kavanagh, Andrade, & May, 2005). Strength of craving imagery reported on the Alcohol Craving Experience questionnaire was used as the outcome variable. As expected, participants with higher craving reported significantly more intense craving-related mental imagery compared to those with lower craving. The effect size for this difference was in the moderate to large range indicating that the difference in the strength of craving imagery experienced between the two groups was practically significant. This result highlights the fact that mental imagery is a central part of craving-related cognition.

Similarly, the second hypothesis that individuals with higher craving would report more frequent mental imagery related to alcohol was also explored using the multivariate analysis of variance. Individuals with high craving reported experiencing significantly more frequent mental imagery related to alcohol in comparison with individuals with lower alcohol craving. Taken together with the result from the examination of the strength of craving imagery, the relationship between craving and mental imagery proposed by Kavanah, Andrade, and May (2005) was
supported. As such, mental imagery may be a useful phenomenon to explore in the development of interventions aimed at reducing alcohol craving or substance use. If mental imagery is a central component of alcohol craving, it is logical to propose that altering or reducing mental imagery would interrupt craving. In fact, some support was found for this idea by Kemps and Tiggemann (2009) and May, Andrade, Panabokke, and Kavanagh (2010) through studies using tasks that competed with mental imagery to disrupt craving-related mental imagery. However, these types of interventions have not been incorporated successfully on a widespread basis into drug and alcohol treatment programs. This may be due to the relatively recent discovery of the role of mental imagery in alcohol craving. Further, additional interventions need to be developed that can be used ‘in the moment’ by individuals experiencing cravings. Thus, laboratory-based techniques may not be applicable in everyday situations. Techniques such as mindfulness meditation, or other interventions used to reduce the impact of cognitions or mental images, may be more appropriate for everyday situations. This will be discussed in further detail later.

The third hypothesis that was examined was that individuals with higher craving would report experiencing more symptoms of anxiety than individuals with lower craving. This hypothesis was also tested using the multivariate analysis of variance with the total score on the State-Trait Inventory of Cognitive and Somatic Anxiety as the dependent variable. Only the trait subscale was used to examine anxiety, without regard to the timing of the test that could have impacted the state subscale. As expected, individuals with higher craving reported significantly higher levels of (trait) anxiety symptoms. It is possible that this finding is related to an inherent similarity between alcohol craving and other obsessive-compulsive anxiety problems. Kavanagh, Andrade, and May (2005) argued that negative emotion is related to higher craving in that it might serve as a trigger for the elaborated intrusion process. As such, this finding supports their
theory. Finally, that anxiety is significantly higher in individuals with high craving indicates that more attention should be focused on anxiety reduction strategies such as progressive relaxation, deep breathing, and meditation in drug and alcohol treatment programs. Individuals in drug and alcohol treatment programs should be tested for craving and anxiety levels to determine the relative importance of these types of interventions.

The fourth hypothesis tested was that individuals with higher craving would report more symptoms of depression than those with lower levels of craving. Similar to the examination of anxiety, the purpose of this hypothesis test was to explore depression as a trigger for the elaborated intrusion process or craving more broadly. The total score on the Quick Inventory of Depressive Symptomatology – Self Report 16 was used as the dependent variable in the MANOVA. No statistically significant result was found, however, the differences between the high and low craving groups approached significance. It is possible that with a larger sample size the difference would have reached statistical significance. However, there does not appear to be a large difference in depression symptoms between those with low craving and those with high craving. Perhaps individuals with clinical depression may be more likely to drink alcohol as suggested by Evren, Cetin, Durkaya, and Dalbudak (2010), or to have intrusive thoughts leading to elaboration, but that was not supported definitively in the current study. That no significant relationship was found partially supports an earlier study by Grant and Stewart (2007) that reported anxiety but not mood induction were related to expectancies regarding the effects of alcohol on changing emotions.

The fifth hypothesis examined was that individuals with high craving would be more likely to use thought suppression than individuals with low craving. This was also tested using MANOVA, with scores on the White Bear Suppression Inventory for Alcohol Related Thoughts
as the dependent variable. A statistically significant result was found with individuals with high craving reporting significantly more use of thought suppression than individuals with low craving. This is an important finding as it supports the idea by Berry, May, Andrade, and Kavanagh (2010) that individuals may use thought suppression to control their craving-related intrusive thoughts. Additionally, it has been found that using thought suppression to control thoughts related to substance use ultimately fails and results in a rebound effect whereby there is increased substance use after failing to control related thoughts (Erskine & Georgiou, 2010; Erskine, Georgiou, & Kvavilashvili, 2010). Based on this finding, it is important to help individuals who experience craving as a part of a substance abuse problem to use more effective cognitive strategies to control their substance-related cognitions or cravings.

The sixth hypothesis examined was that individuals with high craving would be more likely to have a more negative appraisal of their cognition in relation to metacognition than those with low craving. This hypothesis was tested using the MANOVA with the five factor scores of the MCQ-30 as the outcome variables. A significant difference was found between craving groups for the cognitive self-consciousness factor and the need to control thoughts factor with individuals reporting higher levels of craving endorsing each type of metacognition more. Additionally, the difference between groups on the negative beliefs about thoughts concerning uncontrollability and danger factor showed a trend towards statistical significance. No significant differences were found between craving groups on the cognitive confidence factor or positive beliefs about worry factor. As such, the hypothesis was partially supported.

The cognitive self-consciousness factor of the MCQ-30 concerns an individual’s propensity to monitor their thoughts and to evaluate their thoughts closely as they occur (Wells & Cartwright-Hatton, 2003). That individuals with higher levels of alcohol craving more highly
endorsed this type of metacognition indicates that individuals who experience higher levels of craving have a tendency to focus on their own thoughts more than others. As such, their higher level of craving may be related to their overall cognitive style. Alternately, individuals with higher craving may be more aware of their thoughts due to the distressing nature of the thoughts and/or from attempting to control them via a less effective meta-cognitive strategy (e.g., thought suppression). The need to control thoughts factor concerns an individual’s belief that there is a high level of importance on controlling thoughts and that not to do so is a sign of weakness or something worthy of punishment. Individual’s with higher craving may thus see their cravings, and the difficulty they have with managing them, as a sign of weakness or an indication that there is something wrong with them. While there was no statistically significant difference between craving groups on the negative beliefs about thoughts concerning uncontrollability and danger factor, there was a trend towards individuals with higher craving endorsing this factor more. The negative beliefs about thoughts concerning uncontrollability and danger factor is related to an individual’s tendency to worry about their thoughts and to view their thoughts as potentially dangerous. It would be logical for there to be a difference between craving groups on this factor, and the difference may have been significant with a larger sample size.

Finally, that there was no significant difference between craving groups on the cognitive confidence factor, or the positive beliefs about worry factor, may actually support the hypothesis that individuals with high craving would have a more negative appraisal of their metacognition. The cognitive confidence factor concerns an individual’s confidence in their memory and their ability to trust the contents of their memory. That there was no significant difference between groups on this factor shows that both high and low craving individuals feel that they can trust their memory equally. This could result in an individual who is experiencing a high level of
craving trusting faulty cognitions or memories that should be disregarded. Or, no significant
difference on the cognitive confidence factor could show that it is not related to alcohol craving.
Finally, the positive beliefs about worry factor is related to a tendency to believe that worrying
has benefits in coping ability and motivation. Not observing a significant difference between
groups on this factor could indicate that those with high craving levels are just as likely as others
to find benefits in worrying. However, due to the more negative appraisal individuals with high
craving have of their thoughts, no significant difference could be an indication that individuals
with higher craving are not receiving additional benefits from worrying more overall. Like the
cognitive confidence factor, no observed significant difference could also be an indication that
the factor is not related to increased cravings.

Regardless, it is clear that individuals reporting higher levels of craving have a tendency
to focus on their thoughts more and place a higher level of importance on controlling their
thoughts. Additionally, they have a tendency to view not controlling their thoughts as something
that is dangerous and that potentially indicates there is something wrong or deficient about their
struggle to do so. This finding supports the argument by Anton (1999) that individuals with
higher craving have a tendency to focus more on their craving-related intrusive thoughts, and as
a result, become trapped in a ruminative cycle related to trying to control the thoughts. Engaging
in this type of thinking could result in an increase in craving for alcohol to help cope with
negative thoughts. The finding also supports EI theory in that it shows that individuals
experiencing higher levels of craving have a tendency to focus more on their thoughts, which is
expected for individuals trying to cope more with substance-related thought intrusions and
mental imagery (Kavanagh, Andrade, & May, 2005).
The seventh hypotheses tested using the MANOVA was that individuals with higher craving would be more likely to have negative metacognitions related to alcohol than individuals with lower craving. This hypothesis was tested using the combined scores of the uncontrollability and thought-action fusion factor and the unpleasantness factor from the Metacognitions Questionnaire for Alcohol Abusers. There was a trend towards statistical significance in the difference between groups on this factor, however, no statistically significant difference was found. Not observing a significant difference could be due to a variety of factors. First, the value used to determine a significant difference may have been too conservative, however, there was a need to protect against type I error. Second, a larger sample size may have resulted in a statistically significant difference. It is important for future studies to address this to determine what effect, if any, having more negative metacognitions related to alcohol has on craving.

Because several participants did not complete the second part of the study that involved the administration of the attention and working memory tests, analyses involving these tests were conducted separately from the other hypothesis tests. Due to the fact that both the independent and dependent variables involved in analyses related to working memory and attention had continuous interval/ratio data, multiple regression was used to examine the hypotheses related to these constructs. Hypotheses VIII, IX, and X were tested using hierarchical multiple regression. Hypothesis VIII was that alcohol craving-related mental imagery elaboration would be related to attentional bias for alcohol related stimuli with attentional bias predicting higher levels of mental imagery. Hypothesis IX was higher levels of craving imagery elaboration would be related to worse performance on attention and working memory. Finally, hypothesis X was that the relationship between working memory and attention and craving imagery elaboration would be
moderated by family history of alcohol abuse. Hypothesis X was based on the findings of a previous study by Yates (2011) which found that the relationship between sustained attention and alcohol craving was moderated by family history of alcohol abuse in a sample of young adult males and females.

In order to test hypotheses VIII, IX, and X, the attention and working memory variables (Alc-Stroop, WCST, CPT-IP, TRAILS-A, TRAILS-B, and PASAT), as well as the family history variable (FTQ), were entered into block 1 of a hierarchical multiple regression as predictors. All variables were mean centered. In block 2 of the hierarchical multiple regression, the interaction terms for each of the attention and working memory measures with family history of alcohol abuse were entered as predictors. The dependent variable used was the total score on the Alcohol Craving Experience questionnaire, a measure of craving-related mental imagery and thought intrusion. Neither the overall model, nor any of the predictors reached statistical significance. Thus, hypotheses VIII, IX, and X were not supported. While none of the predictor variables significantly predicted craving imagery elaboration, this test does provide an interesting result. Specifically, the results indicate that no specific deficit in working memory or attention was related to craving imagery elaboration. Kavanagh, Andrade, and May (2005) argued that attention and working memory are involved in craving for substances via the elaboration of intrusive thoughts using mental imagery. The current finding does not refute that, it only shows that while attention may be involved in the processing of craving-related thoughts, no deficit in either domain predicted craving imagery elaboration.

Previous studies have found a link between attention, working memory, and craving using brain-imaging technology (Berry, May, Andrade, & Kavanagh, 2010). However, evidence that areas of the brain related to these processes are involved in craving does not mean that
craving is predicated on a deficit in functioning. Further, it is important to recognize that the current study only examined this relationship for males, so it is possible that there is a specific deficit in working memory and attention for females in relation to craving imagery elaboration. The previous study by Yates (2011) found that family history of alcohol abuse moderated the relationship between sustained attention and craving examined both males and females. However, due to the breakdown of participants, males and females were not examined separately in that study. Further, craving was examined more broadly in that study and it did not specifically examine the relationship between craving imagery elaboration and attention. Finally, while attentional bias for alcohol-related stimuli did not significantly predict craving imagery elaboration, a relationship that earlier research suggested (Field, Mufano, & Franken, 2009; Field & Cox, 2008), it is important to point out that the bivariate correlation between attentional bias and craving defined more broadly (OCDS total score) approached statistical significance. Thus, the lack of a statistically significant finding could be due to reduced power from the lower number of participants completing the attention and working memory measures.

Next, hypotheses XI and XIII were examined using the bivariate correlations between the attention and working memory variables and the variables of interest. Hypothesis XI was that individuals with a more negative appraisal of their metacognitions would show worse performance on attention and working memory. As such, the bivariate correlations between the attention and working memory variables and the five factor scores of the MCQ-30 were examined. None of the relationships were statistically significant, thus the hypothesis was not supported. As such, there does not appear to be a link between metacognition and attention and working memory capacity. Hypothesis XIII was that negative alcohol metacognitions would negatively correlate with performance on attention and working memory. To test this hypothesis,
the bivariate correlations between the attention and working memory variables and the combined scores of the uncontrollability and thought-action fusion factor and the unpleasantness factor from the Metacognitions Questionnaire for Alcohol Abusers were examined. Again, no significant correlations were found.

Finally, hypothesis XII, that negative alcohol metacognitions would positively correlate with attentional bias for alcohol-related stimuli, was examined. This was examined using the bivariate correlation between attentional bias (Alc-Stroop) and the combined scores of the uncontrollability and thought-action fusion factor and the unpleasantness factor from the Metacognitions Questionnaire for Alcohol Abusers. No significant correlation was found. These results show that hypotheses XI, XII, and XIII were not supported indicating that metacognition is not related to performance on attention and working memory or to attentional bias for alcohol-related stimuli. This finding provides partial support for the idea that metacognition is related to executive function (Wells & Cartwright-Hatton, 2004), and not the potential slave systems of attention and working memory. While the current results do not directly support a link between attention, working memory, and executive function, it at least provides support to the notion that performance on attention/working memory and metacognition are not related. As with the other hypothesis tests using the attention and working memory measures, it is possible that there was not sufficient power to detect a significant relationship (Type II error).

Evaluation of Exploratory Model

The final analysis conducted was an exploratory analysis of all variables involved in the study. Specifically, variables were entered into a hierarchical multiple regression analysis to determine the importance of each of the variables in the prediction of craving for alcohol. In
contrast to earlier analyses, all of the variables were used for the individuals who completed both parts of the study to better examine how the variables were interrelated. However, only the CPT-IP was used to examine attention as it was found in earlier analyses to be the most significant predictor of craving, and the number of variables included in the analysis had to be restricted to preserve power. Hierarchical multiple regression allows a determination of the variance accounted for by sets of variables over and above that which was accounted for by previously entered sets. The hierarchical multiple regression analysis for the current study was theory-driven based on the description of EI theory by Kavanagh, Andrade, & May (2005). Specifically, in the first block of the hierarchical regression, variables that were more biologically/genetically based were entered (i.e. family history of alcohol abuse, attentional bias for alcohol-related stimuli, and CPT-IP score). The variables chosen for entry in each block were determined based on those variables that would provide the most parsimonious explanation of the data. Additionally, the total score for the MCQ-30 was used as opposed to the individual metacognition factor scores. This method was used for all variables with the exception of the variables related to craving experience from the ACE. In the second block of the hierarchical regression, the cognitive/metacognitive variables were entered (i.e. QIDS, STICSA, MCQ-30, MCQ-A, WBSI-AT). Finally, in the third block of the hierarchical multiple regression analysis, a set of variables measuring the strength and frequency of craving-related mental imagery and craving-related thought intrusions were entered (i.e. ACE-S Img, ACE-S Int, ACE-F Img, ACE-F int). These variables were entered last to determine whether accounting for craving imagery and though intrusion accounts for unique variance over the other study variables as proposed by Kavanagh, Andrade, and May.
The variables from the first block in the hierarchical regression analysis did not significantly predict craving. This result was not unexpected based on prior results from earlier analyses conducted in this study. It is possible that family history of alcohol abuse, attention/working memory, and attentional bias for alcohol-related stimuli are not significantly related to alcohol craving for males. Earlier studies have found a relationship between attention and family history of alcohol abuse, particularly for sons of male alcoholics (Pihl, Peterson, & Finn, 199). The current study did not find a relationship between family history and attention or working memory performance. However, point-biserial correlations between family history of alcohol abuse status and attention as measured by the PASAT were statistically significant, as well as the correlation between family history and attentional bias for alcohol related stimuli (Alc-Stroop). Thus, family history of alcohol abuse and attention and working memory were related, but they did not predict craving for alcohol. Additionally, the results of a prior study by Yates (2011) were not supported, however, that study also included females.

The variables from the second block significantly predicted craving for alcohol as a whole, and there was a significant change in the variance accounted for in craving compared with the variables entered in the first block. The only variable that was a statistically significant predictor in the second block was the STICS, a measure of cognitive and somatic anxiety symptoms. As such, this result underscores the relationship between anxiety and alcohol craving discussed earlier.

Finally, the variables entered in the third block significantly predicted alcohol craving and added a significant level of variance accounted for over-and-above the variables added in the second block. Out of the variables entered in the third block, only the strength of alcohol-related thought intrusions was a statistically significant predictor of craving for alcohol. This
relationship does not discount the earlier finding that individual with higher alcohol craving reported experiencing significantly more alcohol-related mental imagery. Rather, it indicates that craving-related thought intrusions are a more important variable in predicting alcohol craving.

Taken together, the results of the hierarchical multiple regression suggest that the most important variables in predicting alcohol craving include trait anxiety and the strength of alcohol-related thought intrusions. This finding calls into question the importance that Kavanagh, Andrade, and May (2005) have placed on conscious craving-related mental imagery elaboration. Specifically, the results of the current study show that the strength of alcohol-related thought intrusions is the strongest predictor of craving for alcohol. While it may be that craving-related mental imagery elaboration and thought intrusions both differentiate between individuals with high and low craving levels, alcohol-related thought intrusions appear to be the more important predictor of craving obsessions and compulsions.

Treatment Recommendations and Clinical Implications

Based on the results of the current study, a number of treatment recommendations can be made with respect to alcohol. First, all individuals entering drug and alcohol treatment programs should be evaluated for craving which is something that will be more likely in the future due to changes in the diagnostic criteria for addiction disorders (O’Brien, 2010). While not all individuals with alcohol abuse or dependence experience high levels of craving, it is an indicator of the severity of addiction. Because of this, it is important to determine if specific interventions should be used to reduce and manage cravings.

Second, interventions that help with managing emotionally-laden mental imagery may be useful in the reduction of craving due to the strength and frequency with which individuals with
high levels of craving experience these types of images. Interventions that have been used in the treatment of the mental images involved in PTSD may be helpful in reducing craving-related mental imagery. The use of narrative imagery interventions suggested by Costa, Lang, Sabatinelli, Versace, and Bradley (2010) may be helpful in reducing emotionally-laden mental imagery as narrative imagery engages the same brain areas related to emotion and imagery.

Third, more focus should be placed on anxiety reduction in drug and alcohol treatment programs. Stress-reduction techniques such as deep breathing, mindfulness meditation, progressive-muscle relaxation, and other imagery-based relaxation techniques should be taught. This is especially important given the relative importance of anxiety found in the current study in predicting craving for alcohol.

Fourth, given the obsessional nature of craving, and drug and alcohol use as a whole, interventions that are used for the treatment of obsessions should be applied more often in drug and alcohol treatment programs. Additionally, because individuals with higher craving are more likely to use thought suppression to control their substance-related cognitions, helping them to learn other strategies that do not cause a substance use rebound effect may be important. Salkovskis and Reynolds (1994) discussed an intervention that specifically reduced substance-related intrusive thoughts, induced relaxation, and did not result in a rebound effect. Specifically, they had individuals engage in deep breathing while silently counting slowly and focusing on their breathing. The use of these types of techniques in drug and alcohol treatment programs, as well as proper psychoeducation with regards to the nature of cravings and attempting to suppress cravings, are important. Individuals need to recognize the futile nature of trying to suppress substance-related cognitions and may not be aware of the problematic nature of trying to do so.
Fifth, interventions should be taught to those with alcohol abuse or dependence that focus on changing metacognitions and the strategies that individuals use to evaluate distressing thoughts. Interventions such as those discussed by Wells (2011) using metacognitive therapy may be helpful in the reduction of craving. Specifically, metacognitive therapy is a type of cognitive behavioral therapy that focuses on changing how an individual responds to their thoughts. This is analogous to the types of strategies an individual might learn in Alcoholics Anonymous such as the importance of taking things slowly, living in the present, and talking about problems openly. Based on the results of the current study, it is important to target specific types of metacognitions such as the relative importance an individual places on their own thoughts and the negative evaluations that individuals have with regards to thoughts they may believe indicate that there is something “bad” or “wrong” with them.

Overall, the results of the current study provide fertile ground for the development of new interventions and policies for the treatment of substance use disorders. While the medical model of substance use disorders has replaced the notion that addiction is a personal or moral failing, many drug and alcohol treatment programs still rely heavily on the exploration of related issues. It is important to shift the focus of drug and alcohol treatment away from moral failings while still recognizing the consequences of behaviors that an individual engages in while under the influence. A majority of drug and alcohol treatment programs today focus on the exploration of negative past behaviors, and replacing those past behaviors with behavioral awareness and spirituality. These are important aspects of treatment, but not to the exclusion of research-based interventions that could be more effective. Only a minority of individuals are able to sustain long-term recovery with the current state of addiction treatment, and this may be due to a lack of integration of what is known in the field with regard to addiction and actual treatment practices.
As such, the treatment recommendations provided, and the results of the current study, add to the growing body of knowledge of addiction and addiction treatment.

Limitations

There were a few limitations to the current study that are important to account for in interpreting the results of this study. One of the biggest limitations of the current study was that several individuals did not complete both parts of the study. This had the effect of reducing statistical power for analyses that examined attention and working memory. Some potential relationships were not explored fully because of a limitation on the analyses that could be conducted due to missing data from the participants that did not complete part two of the study. Additionally, only males were used in the current study, so the results may not generalize to females. Another limitation to the current study was that the sample used for the current study included only young adult males who were recruited from a population of university students. There may be important differences between the functioning of these individuals and other individuals that may be more likely to enter drug and alcohol treatment programs. However, substance abuse is a significant problem on college campuses, and thus, the results of this study are still valuable. Additionally, it is logical to assume that craving for alcohol operates similarly across a variety of individuals. As such, the results of this study provide a good indication to the types of processes involved in alcohol craving. Another important limitation to the current study was that only craving for alcohol use was examined, thus care should be taken in generalizing the results to craving for other substances. However, multiple other studies have shown that craving operates in a similar manner regardless of the substance used which is one of the benefits of the elaborated intrusion theory of desire (Kavanagh, Andrade, & May, 2005).
Directions for Future Research

As mentioned in the treatment recommendations, there are a variety of potential psychological interventions that might be useful in the reduction of craving and the overall treatment of addiction disorders. Specifically, metacognitive therapy (Wells, 2011) may provide useful interventions to target the types of metacognitions that individuals with high levels of craving experience. As such, clinical studies need to be conducted explicitly examining the effect of these interventions on craving reduction. Further, with the tendency for individuals with high levels of craving to have faulty metacognitions and engage in thought suppression strategies, it may be useful to develop an empirically based set of metacognitive or cognitive addictive thinking errors. By identifying these errors specifically, group interventions could be developed that provide psychoeducation on the use of thinking errors and ways to counteract them.

While the current study did not find a relationship between family history of alcohol abuse, attention, and craving for alcohol like that found in an earlier study by Yates (2011), it is important to continue to explore this relationship. Specifically, the earlier study included both males and females, and as such, it is important to explore the relationship between family history of alcohol abuse, attention, and craving in females. It may be possible that family history of alcohol abuse and neurocognitive function affect craving more in females, especially young adult females.

Another important area to explore with future research is the reduction of craving imagery and the strength of craving-related thought intrusions using individual and group based interventions. Given the relative importance of craving imagery and craving-related thought intrusions in the prediction of craving, more needs to be done to develop interventions that can be applied in any setting by an individual experiencing craving. Substance use disorders are
traditionally treated in a group format, so finding ways to incorporate interventions in this format may be helpful. Potential ways to do this include the use of multimedia in psychotherapy groups to help with exploring craving-related imagery. Alternately, explicitly discussing the intensity of substance-related thought intrusions in a group format, as well as individual’s experiences with substance-related mental imagery may improve treatment outcomes. As such, clinical studies should be conducted incorporating current knowledge regarding craving for substances. Comparing treatment protocols that use the interventions discussed in this study, and other interventions that have similar goals, with current treatment protocols would be a valuable endeavor.
Table 1

Demographics

<table>
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<th>Variable</th>
<th>Frequency (%)</th>
<th>Problem Drinkers (%)</th>
<th>High Craving (%)</th>
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<tr>
<td>Ethnicity</td>
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<tr>
<td>White/Caucasian</td>
<td>60 (50.4)</td>
<td>19 (16.0)</td>
<td>18 (15.1)</td>
</tr>
<tr>
<td>Black/African American</td>
<td>24 (20.2)</td>
<td>5 (4.2)</td>
<td>8 (6.7)</td>
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<tr>
<td>Hispanic/Latino</td>
<td>19 (16.0)</td>
<td>6 (5.0)</td>
<td>3 (2.5)</td>
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<tr>
<td>Asian/Pacific Islander</td>
<td>11 (9.2)</td>
<td>4 (3.4)</td>
<td>3 (2.5)</td>
</tr>
<tr>
<td>Native American</td>
<td>1 (0.8)</td>
<td>1 (0.8)</td>
<td>1 (0.8)</td>
</tr>
<tr>
<td>Other</td>
<td>4 (3.4)</td>
<td>2 (1.7)</td>
<td>3 (2.5)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>119 (100.0)</td>
<td>37 (31.3)</td>
<td>36 (30.3)</td>
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</table>

Note. Problem drinkers defined as individuals with Alcohol Use Disorders Identification Test scores of 8 or higher (Babor, Higgins-Biddle, Saunders, & Monteiro, 2001). High craving defined as individuals with Obsessive Compulsive Drinking Scale scores of 7 or higher (Anton, Moak, & Latham, 1995).
Table 2

Descriptive Statistics

<table>
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<th>Question</th>
<th>Frequency (%)</th>
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<tr>
<td>History of head injury</td>
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<tr>
<td>Yes</td>
<td>10 (8.4)</td>
</tr>
<tr>
<td>No</td>
<td>109 (91.6)</td>
</tr>
<tr>
<td>Do you drink alcohol</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>96 (80.7)</td>
</tr>
<tr>
<td>No</td>
<td>23 (19.3)</td>
</tr>
<tr>
<td>Drug use other than alcohol</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>26 (21.8)</td>
</tr>
<tr>
<td>No</td>
<td>93 (78.2)</td>
</tr>
<tr>
<td>Family history of alcoholism</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>51 (42.9)</td>
</tr>
<tr>
<td>No</td>
<td>68 (57.1)</td>
</tr>
</tbody>
</table>

Note. Individuals with a history of head injury were classified as those who were knocked unconscious for a minimum of 2 minutes after hitting their head. Drug use other than alcohol was limited to non-preservation illicit drug use. Family history of alcoholism was defined as individuals who reported having problem or possible problem drinkers in their family history on the Family Tree Questionnaire using the liberal scoring criteria (Mann, Sobell, Sobell, & Sobell, 1985).
Table 3

Comparison of Participants Who Completed vs Did Not Complete Entire Study.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Completed Whole Study</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes (n=76)</td>
<td>No (n=43)</td>
</tr>
<tr>
<td>OCDS</td>
<td>5.82 (6.136)</td>
<td>5.14 (5.321)</td>
</tr>
<tr>
<td>AUDIT</td>
<td>6.07 (4.873)</td>
<td>6.42 (5.279)</td>
</tr>
<tr>
<td>Age</td>
<td>20.95 (2.550)</td>
<td>21.05 (2.811)</td>
</tr>
<tr>
<td>Age at 1st drink</td>
<td>17.15 (2.093)</td>
<td>17.38 (2.270)</td>
</tr>
<tr>
<td>Drinks per week</td>
<td>3.53 (4.778)</td>
<td>4.80 (6.967)</td>
</tr>
<tr>
<td>Number of FH+ relatives</td>
<td>1.16 (1.415)</td>
<td>1.42 (1.531)</td>
</tr>
<tr>
<td>QIDS</td>
<td>5.43 (3.855)</td>
<td>5.51 (4.377)</td>
</tr>
<tr>
<td>STICSA</td>
<td>32.54 (8.994)</td>
<td>33.70 (10.881)</td>
</tr>
<tr>
<td>ACE</td>
<td>42.69 (40.357)</td>
<td>39.00 (40.743)</td>
</tr>
<tr>
<td>MCQ-30</td>
<td>57.19 (12.103)</td>
<td>57.63 (14.461)</td>
</tr>
<tr>
<td>MCQ-A</td>
<td>34.47 (11.682)</td>
<td>34.30 (13.456)</td>
</tr>
<tr>
<td>WBSI-AT</td>
<td>27.79 (10.803)</td>
<td>25.07 (11.226)</td>
</tr>
</tbody>
</table>

Note. OCDS = Obsessive Compulsive Drinking Scale; AUDIT = Alcohol Use Disorders Identification Test; QIDS = Quick Inventory of Depressive Symptomatology; STICSA = State Trait Inventory of Cognitive and Somatic Anxiety; ACE = Alcohol Craving Experiences Questionnaire; MCQ-30 = Metacognitions Questionnaire – 30; MCQ-A = Metacognition Questionnaire for Alcohol Abusers; WBSI-AT = White Bear Suppression Inventory for Alcohol Related Thoughts.
Table 4

*Measures of Alcohol Use and Craving*

<table>
<thead>
<tr>
<th>Measure</th>
<th>$M$</th>
<th>$SD$</th>
<th>Skew</th>
<th>Kurtosis</th>
<th>$\alpha$</th>
<th>$MIC$</th>
</tr>
</thead>
<tbody>
<tr>
<td>OCDS</td>
<td>5.57</td>
<td>5.84</td>
<td>1.53</td>
<td>2.01</td>
<td>.895</td>
<td>.412</td>
</tr>
<tr>
<td>AUDIT</td>
<td>6.19</td>
<td>5.00</td>
<td>.870</td>
<td>.253</td>
<td>.802</td>
<td>.294</td>
</tr>
<tr>
<td>ACE</td>
<td>41.36</td>
<td>40.36</td>
<td>1.117</td>
<td>.652</td>
<td>.984</td>
<td>.685</td>
</tr>
<tr>
<td>ACE-S</td>
<td>22.22</td>
<td>20.07</td>
<td>.974</td>
<td>.563</td>
<td>.953</td>
<td>.620</td>
</tr>
<tr>
<td>ACE-F</td>
<td>19.14</td>
<td>20.98</td>
<td>1.269</td>
<td>.797</td>
<td>.980</td>
<td>.761</td>
</tr>
<tr>
<td>ACE-S Intensity</td>
<td>9.54</td>
<td>8.08</td>
<td>.650</td>
<td>-.241</td>
<td>.907</td>
<td>.671</td>
</tr>
<tr>
<td>ACE-S Imagery</td>
<td>9.69</td>
<td>10.37</td>
<td>1.063</td>
<td>.268</td>
<td>.952</td>
<td>.778</td>
</tr>
<tr>
<td>ACE-S Intrusion</td>
<td>2.99</td>
<td>4.08</td>
<td>1.435</td>
<td>1.313</td>
<td>.904</td>
<td>.825</td>
</tr>
<tr>
<td>ACE-F Intensity</td>
<td>7.50</td>
<td>7.87</td>
<td>1.107</td>
<td>.384</td>
<td>.961</td>
<td>.803</td>
</tr>
<tr>
<td>ACE-F Imagery</td>
<td>9.01</td>
<td>10.38</td>
<td>1.197</td>
<td>.413</td>
<td>.964</td>
<td>.824</td>
</tr>
<tr>
<td>ACE-F Intrusion</td>
<td>2.63</td>
<td>3.99</td>
<td>1.841</td>
<td>2.833</td>
<td>.945</td>
<td>.817</td>
</tr>
</tbody>
</table>

*Note.* $N=119$. OCDS = Obsessive Compulsive Drinking Scale; AUDIT = Alcohol Use Disorders Identification Test; ACE = Alcohol Craving Experiences Questionnaire; ACE-S = Alcohol Craving Experiences Questionnaire – Strength of Craving Imagery Scale; ACE-F = Alcohol Craving Experiences Questionnaire – Frequency of Craving Imagery Scale.
Table 5

*Measures of Metacognition*

<table>
<thead>
<tr>
<th>Measure</th>
<th>$M$</th>
<th>$SD$</th>
<th>Skew</th>
<th>Kurtosis</th>
<th>$a$</th>
<th>MIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBSI – AT</td>
<td>26.81</td>
<td>10.98</td>
<td>.689</td>
<td>-.780</td>
<td>.936</td>
<td>.508</td>
</tr>
<tr>
<td>MCQ - 30</td>
<td>57.35</td>
<td>12.94</td>
<td>.018</td>
<td>-.352</td>
<td>.891</td>
<td>.217</td>
</tr>
<tr>
<td>MCQ – 30 Cog</td>
<td>9.64</td>
<td>3.83</td>
<td>1.220</td>
<td>.892</td>
<td>.874</td>
<td>.548</td>
</tr>
<tr>
<td>MCQ – 30 Pos</td>
<td>9.13</td>
<td>3.44</td>
<td>1.231</td>
<td>1.382</td>
<td>.893</td>
<td>.588</td>
</tr>
<tr>
<td>MCQ – 30 Self</td>
<td>17.06</td>
<td>5.04</td>
<td>-.525</td>
<td>-.556</td>
<td>.913</td>
<td>.635</td>
</tr>
<tr>
<td>MCQ – 30 Unc</td>
<td>9.84</td>
<td>4.34</td>
<td>1.238</td>
<td>1.164</td>
<td>.896</td>
<td>.588</td>
</tr>
<tr>
<td>MCQ – 30 Need</td>
<td>11.68</td>
<td>4.04</td>
<td>.326</td>
<td>-.914</td>
<td>.808</td>
<td>.416</td>
</tr>
<tr>
<td>MCQ - A</td>
<td>34.41</td>
<td>12.29</td>
<td>.098</td>
<td>-.664</td>
<td>.929</td>
<td>.465</td>
</tr>
</tbody>
</table>

*Note.* $N=119$. WBSI-AT = White Bear Suppression Inventory for Alcohol Related Thoughts; MCQ-30 = Metacognitions Questionnaire – 30; MCQ – 30 Cog = Metacognitions Questionnaire – 30 cognitive confidence scale; MCQ – 30 Pos = Metacognitions Questionnaire – 30 positive beliefs about worry scale; MCQ – 30 Self = Metacognitions Questionnaire – 30 cognitive self-consciousness scale; MCQ – 30 Unc = Metacognitions Questionnaire – 30 negative beliefs about thoughts concerning uncontrollability and danger scale; MCQ – 30 Need = Metacognitions Questionnaire – 30 need to control thoughts scale; MCQ – A = Metacognition Questionnaire for Alcohol Abusers.
### Table 6

**Measures of Anxiety and Depression**

<table>
<thead>
<tr>
<th>Measure</th>
<th>$M$</th>
<th>$SD$</th>
<th>Skew</th>
<th>Kurtosis</th>
<th>$\alpha$</th>
<th>MIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>STICSA</td>
<td>32.96</td>
<td>9.68</td>
<td>.984</td>
<td>1.145</td>
<td>.911</td>
<td>.331</td>
</tr>
<tr>
<td>STICSA – Cog</td>
<td>17.50</td>
<td>6.32</td>
<td>.706</td>
<td>-.257</td>
<td>.889</td>
<td>.446</td>
</tr>
<tr>
<td>STICSA – Som</td>
<td>15.45</td>
<td>4.29</td>
<td>1.490</td>
<td>3.195</td>
<td>.821</td>
<td>.355</td>
</tr>
<tr>
<td>QIDS</td>
<td>5.46</td>
<td>4.03</td>
<td>1.132</td>
<td>1.786</td>
<td>.658</td>
<td>.135</td>
</tr>
</tbody>
</table>

*Note. N=119. STICSA = State-Trait Inventory of Cognitive and Somatic Anxiety; STICSA – Cog = State-Trait Inventory of Cognitive and Somatic Anxiety – cognitive anxiety scale; STICSA – Som = State-Trait Inventory of Cognitive and Somatic Anxiety – somatic anxiety scale; QIDS = Quick Inventory of Depressive Symptoms – Self Report 16.*
Table 7

**Missing Data Analysis**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Original Data</th>
<th>ML Data</th>
<th>Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>CPTIP</td>
<td>1.775</td>
<td>.861</td>
<td>1.805</td>
</tr>
<tr>
<td>WCST</td>
<td>16.07</td>
<td>6.282</td>
<td>16.27</td>
</tr>
<tr>
<td>PASAT</td>
<td>157.93</td>
<td>27.269</td>
<td>157.09</td>
</tr>
<tr>
<td>PASAT-A</td>
<td>41.87</td>
<td>6.504</td>
<td>41.70</td>
</tr>
<tr>
<td>PASAT-B</td>
<td>40.68</td>
<td>7.018</td>
<td>40.46</td>
</tr>
<tr>
<td>PASAT-C</td>
<td>39.07</td>
<td>7.734</td>
<td>38.84</td>
</tr>
<tr>
<td>PASAT-D</td>
<td>36.32</td>
<td>8.853</td>
<td>36.10</td>
</tr>
<tr>
<td>TRAILS-A</td>
<td>23552.797</td>
<td>4228.757</td>
<td>23625.619</td>
</tr>
<tr>
<td>TRAILS-B</td>
<td>32359.007</td>
<td>8157.081</td>
<td>32924.344</td>
</tr>
<tr>
<td>Alc-Stroop</td>
<td>.031</td>
<td>.183</td>
<td>.035</td>
</tr>
<tr>
<td>Alc-Stroop-C</td>
<td>.676</td>
<td>.229</td>
<td>.677</td>
</tr>
<tr>
<td>Alc-Stroop-H</td>
<td>.692</td>
<td>.206</td>
<td>.695</td>
</tr>
<tr>
<td>Alc-Stroop-A</td>
<td>.722</td>
<td>.282</td>
<td>.731</td>
</tr>
</tbody>
</table>

*Note. N=76. Missing data analysis conducted with maximum likelihood estimation using the expectation-maximization algorithm. CPTIP = Continuous Performance Tests – Identical Pairs; WCST = Wisconsin Card Sorting Test – Perseverative Errors; PASAT = Paced Auditory Serial Addition Test; PASAT-A = Paced Auditory Serial Addition Test – Block A; PASAT-B = Paced Auditory Serial Addition Test – Block B; PASAT-C = Paced Auditory Serial Addition Test – Block C; PASAT-D = Paced Serial Addition Test – Block D; TRAILS-A = Trail-Making Test A; TRAILS-B = Trail-Making Test B; Alc-Stroop = Alcohol Stroop Interference Score; Alc-Stroop-C = Reaction time for Alcohol Stroop color trial; Alc-Stroop-H = Reaction time for Alcohol Stroop household items trial; Alc-Stroop-A = Reaction time for Alcohol Stroop alcohol items trial.*
Table 8

*Measures of Attention and Working Memory*

<table>
<thead>
<tr>
<th>Measure</th>
<th>$M$</th>
<th>$SD$</th>
<th>Skew</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPTIP</td>
<td>1.805</td>
<td>.853</td>
<td>-.214</td>
<td>.498</td>
</tr>
<tr>
<td>WCST</td>
<td>16.27</td>
<td>6.34</td>
<td>.882</td>
<td>.894</td>
</tr>
<tr>
<td>PASAT</td>
<td>157.09</td>
<td>28.07</td>
<td>-.822</td>
<td>-.257</td>
</tr>
<tr>
<td>PASAT-A</td>
<td>41.70</td>
<td>6.62</td>
<td>-.881</td>
<td>-.229</td>
</tr>
<tr>
<td>PASAT-B</td>
<td>40.46</td>
<td>7.23</td>
<td>-1.183</td>
<td>.934</td>
</tr>
<tr>
<td>PASAT-C</td>
<td>38.84</td>
<td>7.94</td>
<td>-.884</td>
<td>-.234</td>
</tr>
<tr>
<td>PASAT-D</td>
<td>36.10</td>
<td>9.01</td>
<td>-.539</td>
<td>-.496</td>
</tr>
<tr>
<td>TRAILS-A</td>
<td>23625.61</td>
<td>4209.88</td>
<td>.709</td>
<td>.599</td>
</tr>
<tr>
<td>TRAILS-B</td>
<td>32924.33</td>
<td>8502.19</td>
<td>.668</td>
<td>-.126</td>
</tr>
<tr>
<td>Alc-Stroop</td>
<td>.022</td>
<td>.106</td>
<td>.258</td>
<td>2.250</td>
</tr>
<tr>
<td>Alc-Stroop-C</td>
<td>.669</td>
<td>.193</td>
<td>1.400</td>
<td>1.484</td>
</tr>
<tr>
<td>Alc-Stroop-H</td>
<td>.695</td>
<td>.208</td>
<td>1.612</td>
<td>2.898</td>
</tr>
<tr>
<td>Alc-Stroop-A</td>
<td>.708</td>
<td>.191</td>
<td>.853</td>
<td>.163</td>
</tr>
</tbody>
</table>

*Note.* $N=76$. CPTIP = Continuous Performance Tests – Identical Pairs; WCST = Wisconsin Card Sorting Test – Perseverative Errors; PASAT = Paced Auditory Serial Addition Test; PASAT-A = Paced Auditory Serial Addition Test – Block A; PASAT-B = Paced Auditory Serial Addition Test – Block B; PASAT-C = Paced Auditory Serial Addition Test – Block C; PASAT – D = Paced Serial Addition Test – Block D; TRAILS-A = Trail-Making Test A; TRAILS-B = Trail-Making Test B; Alc-Stroop = Alcohol Stroop Interference Score; Alc-Stroop-C = Reaction time for Alcohol Stroop color trial; Alc-Stroop-H = Reaction time for Alcohol Stroop household items trial; Alc-Stroop-A = Reaction time for Alcohol Stroop alcohol items trial.
Table 9

*Correlations of Attention and Working Memory Measures*

<table>
<thead>
<tr>
<th>Measure</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CPTIP</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. WCST</td>
<td>-.075</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. PASAT</td>
<td>.440**</td>
<td>-.477**</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. TRAILS-A</td>
<td>-.327**</td>
<td>.292*</td>
<td>-.384**</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. TRAILS-B</td>
<td>-.422**</td>
<td>.513**</td>
<td>-.709**</td>
<td>.692**</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>6. Alc-Stroop</td>
<td>.063</td>
<td>.107</td>
<td>.066</td>
<td>.143</td>
<td>.086</td>
<td>-</td>
</tr>
</tbody>
</table>

*Note. N = 76. CPTIP = Continuous Performance Tests – Identical Pairs; WCST = Wisconsin Card Sorting Test – Perseverative Errors; PASAT = Paced Auditory Serial Addition Test; TRAILS-A = Trail-Making Test A; TRAILS-B = Trail-Making Test B; Alc-Stroop = Alcohol Stroop Interference Score. * p < .05, ** p < .01, two-tailed.*
Table 10

Summary of Means and Standard Deviations for Alcohol Stroop Test Reaction Times

<table>
<thead>
<tr>
<th>Measure</th>
<th>$M$</th>
<th>$SD$</th>
</tr>
</thead>
<tbody>
<tr>
<td>XXXX</td>
<td>.669</td>
<td>.193</td>
</tr>
<tr>
<td>Household</td>
<td>.695</td>
<td>.208</td>
</tr>
<tr>
<td>Alcohol</td>
<td>.708</td>
<td>.191</td>
</tr>
<tr>
<td>Interference</td>
<td>.022</td>
<td>.106</td>
</tr>
</tbody>
</table>

*Note. $N = 76$. XXXX = trials with XXX in different print colors; Household = household item words in different print colors; Alcohol = alcohol related words in different print colors; Interference = difference in reaction time of Household item trials and Alcohol trials.*
Table 11

Summary of Correlations Between Alcohol Measures and Attention Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>CPTIP</th>
<th>WCST</th>
<th>TRAILS-A</th>
<th>TRAILS-B</th>
<th>PASAT</th>
<th>Alc-Stroop</th>
</tr>
</thead>
<tbody>
<tr>
<td>OCDS</td>
<td>-.176</td>
<td>.144</td>
<td>.151</td>
<td>.107</td>
<td>-.083</td>
<td>.242*</td>
</tr>
<tr>
<td>AUDIT</td>
<td>-.006</td>
<td>-.016</td>
<td>-.024</td>
<td>-.035</td>
<td>.017</td>
<td>.173</td>
</tr>
<tr>
<td>ACE</td>
<td>-.151</td>
<td>-.091</td>
<td>.086</td>
<td>-.096</td>
<td>.068</td>
<td>-.012</td>
</tr>
<tr>
<td>ACE-S</td>
<td>-.172</td>
<td>-.107</td>
<td>.113</td>
<td>-.073</td>
<td>.033</td>
<td>-.016</td>
</tr>
<tr>
<td>ACE-F</td>
<td>-.124</td>
<td>-.072</td>
<td>.058</td>
<td>-.114</td>
<td>.100</td>
<td>-.007</td>
</tr>
</tbody>
</table>

Note. N=76. CPTIP = Continuous Performance Tests – Identical Pairs; WCST = Wisconsin Card Sorting Test – Perseverative Errors; PASAT = Paced Auditory Serial Addition Test; TRAILS-A = Trail-Making Test A; TRAILS-B = Trail-Making Test B; Alc-Stroop = Alcohol Stroop Interference Score; OCDS = Obsessive Compulsive Drinking Scale; AUDIT = Alcohol Use Disorders Identification Test; ACE = Alcohol Craving Experiences Questionnaire; ACE-S = Alcohol Craving Experiences Questionnaire – Strength of Craving Imagery Scale; ACE-F = Alcohol Craving Experiences Questionnaire – Frequency of Craving Imagery Scale. * p < .05, ** p < .01, two-tailed.
### Table 12

**Summary of Correlations Between Alcohol Measures and Measures of Emotional Symptoms**

<table>
<thead>
<tr>
<th>Measure</th>
<th>OCDS</th>
<th>AUDIT</th>
<th>ACE</th>
<th>ACE-S</th>
<th>ACE-F</th>
</tr>
</thead>
<tbody>
<tr>
<td>QIDS</td>
<td><strong>.310</strong></td>
<td>.132</td>
<td><strong>.245</strong></td>
<td><strong>.252</strong></td>
<td><strong>.229</strong></td>
</tr>
<tr>
<td>STICSA</td>
<td><strong>.357</strong></td>
<td><strong>.232</strong></td>
<td><strong>.347</strong></td>
<td><strong>.348</strong></td>
<td><strong>.336</strong></td>
</tr>
<tr>
<td>STICSA-Som</td>
<td><strong>.350</strong></td>
<td><strong>.224</strong></td>
<td><strong>.299</strong></td>
<td><strong>.298</strong></td>
<td><strong>.290</strong></td>
</tr>
<tr>
<td>STICSA-Cog</td>
<td><strong>.309</strong></td>
<td><strong>.203</strong></td>
<td><strong>.344</strong></td>
<td><strong>.346</strong></td>
<td><strong>.331</strong></td>
</tr>
</tbody>
</table>

*Note. N=119. OCDS = Obsessive Compulsive Drinking Scale; AUDIT = Alcohol Use Disorders Identification Test; ACE = Alcohol Craving Experiences Questionnaire; ACE-S = Alcohol Craving Experiences Questionnaire – Strength of Craving Imagery Scale; ACE-F = Alcohol Craving Experiences Questionnaire – Frequency of Craving Imagery Scale; STICSA = State-Trait Inventory of Cognitive and Somatic Anxiety; STICSA – Cog = State-Trait Inventory of Cognitive and Somatic Anxiety – cognitive anxiety scale; STICSA – Som = State-Trait Inventory of Cognitive and Somatic Anxiety – somatic anxiety scale; QIDS = Quick Inventory of Depressive Symptomatology – Self Report 16. *p < .05, **p < .01, two-tailed.*
Table 13

*Summary of Correlations Between Alcohol Measures and Metacognition Measures*

<table>
<thead>
<tr>
<th>Measure</th>
<th>OCDS</th>
<th>AUDIT</th>
<th>ACE</th>
<th>ACE-S</th>
<th>ACE-F</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBSI – AT</td>
<td>.371**</td>
<td>.093</td>
<td>.348**</td>
<td>.362**</td>
<td>.323**</td>
</tr>
<tr>
<td>MCQ - 30</td>
<td>.276**</td>
<td>.184*</td>
<td>.307**</td>
<td>.318**</td>
<td>.287**</td>
</tr>
<tr>
<td>MCQ – 30 Cog</td>
<td>.179</td>
<td>-.004</td>
<td>.133</td>
<td>.128</td>
<td>.134</td>
</tr>
<tr>
<td>MCQ – 30 Pos</td>
<td>.034</td>
<td>.111</td>
<td>.247**</td>
<td>.255**</td>
<td>.230*</td>
</tr>
<tr>
<td>MCQ – 30 Self</td>
<td>.226*</td>
<td>.213*</td>
<td>.151</td>
<td>.176</td>
<td>.122</td>
</tr>
<tr>
<td>MCQ – 30 Unc</td>
<td>.172</td>
<td>.135</td>
<td>.257**</td>
<td>.248**</td>
<td>.257**</td>
</tr>
<tr>
<td>MCQ – 30 Need</td>
<td>.219*</td>
<td>.088</td>
<td>.183*</td>
<td>.193*</td>
<td>.167</td>
</tr>
<tr>
<td>MCQ - A</td>
<td>.289**</td>
<td>.066</td>
<td>.247**</td>
<td>.242**</td>
<td>.243**</td>
</tr>
</tbody>
</table>

*Note. N=119. OCDS = Obsessive Compulsive Drinking Scale; AUDIT = Alcohol Use Disorders Identification Test; ACE = Alcohol Craving Experiences Questionnaire; ACE-S = Alcohol Craving Experiences Questionnaire – Strength of Craving Imagery Scale; ACE-F = Alcohol Craving Experiences Questionnaire – Frequency of Craving Imagery Scale; WBSI-AT = White Bear Suppression Inventory for Alcohol Related Thoughts; MCQ-30 = Metacognitions Questionnaire – 30; MCQ – 30 Cog = Metacognitions Questionnaire – 30 cognitive confidence scale; MCQ – 30 Pos = Metacognitions Questionnaire – 30 positive beliefs about worry scale; MCQ – 30 Self = Metacognitions Questionnaire – 30 cognitive self-consciousness scale; MCQ – 30 Unc = Metacognitions Questionnaire – 30 negative beliefs about thoughts concerning uncontrollability and danger scale; MCQ – 30 Need = Metacognitions Questionnaire – 30 need to control thoughts scale; MCQ – A = Metacognition Questionnaire for Alcohol Abusers. * p < .05, ** p < .01, two-tailed.*
Table 14

Summary of Correlations Between Attention Measures and Measures of Emotional Symptoms

<table>
<thead>
<tr>
<th>Measure</th>
<th>CPTIP</th>
<th>WCST</th>
<th>TRAILS-A</th>
<th>TRAILS-B</th>
<th>PASAT</th>
<th>Alc-Stroop</th>
</tr>
</thead>
<tbody>
<tr>
<td>STICSA</td>
<td>-.057</td>
<td>.027</td>
<td>-.052</td>
<td>-.107</td>
<td>.083</td>
<td>.081</td>
</tr>
<tr>
<td>STICSA – Cog</td>
<td>-.051</td>
<td>.007</td>
<td>-.073</td>
<td>-.090</td>
<td>.073</td>
<td>.092</td>
</tr>
<tr>
<td>STICSA – Som</td>
<td>-.051</td>
<td>.050</td>
<td>-.007</td>
<td>-.107</td>
<td>.078</td>
<td>.044</td>
</tr>
<tr>
<td>QIDS</td>
<td>-.216</td>
<td>-.001</td>
<td>.038</td>
<td>.045</td>
<td>-.070</td>
<td>.339**</td>
</tr>
</tbody>
</table>

*Note. N=76. STICSA = State-Trait Inventory of Cognitive and Somatic Anxiety; STICSA – Cog = State-Trait Inventory of Cognitive and Somatic Anxiety – cognitive anxiety scale; STICSA – Som = State-Trait Inventory of Cognitive and Somatic Anxiety – somatic anxiety scale; QIDS = Quick Inventory of Depressive Symptomatology – Self Report 16; CPTIP = Continuous Performance Tests – Identical Pairs; WCST = Wisconsin Card Sorting Test – Perseverative Errors; PASAT = Paced Auditory Serial Addition Test; TRAILS-A = Trail-Making Test A; TRAILS-B = Trail-Making Test B; Alc-Stroop = Alcohol Stroop Interference Score. ** p < .01, two-tailed.
Table 15

*Summary of Correlations Between Attention Measures and Metacognition Measures*

<table>
<thead>
<tr>
<th>Measure</th>
<th>CPTIP</th>
<th>WCST</th>
<th>TRAILS-A</th>
<th>TRAILS-B</th>
<th>PASAT</th>
<th>Alc-Stroop</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBSI – AT</td>
<td>-0.033</td>
<td>0.082</td>
<td>0.164</td>
<td>0.131</td>
<td>-0.025</td>
<td>0.121</td>
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<tr>
<td>MCQ - 30 Cog</td>
<td>-0.233*</td>
<td>-0.033</td>
<td>0.045</td>
<td>0.062</td>
<td>-0.004</td>
<td>-0.025</td>
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<tr>
<td>MCQ – 30 Pos</td>
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<td>0.068</td>
<td>-0.039</td>
<td>-0.106</td>
<td>0.089</td>
<td>0.046</td>
</tr>
<tr>
<td>MCQ – 30 Self</td>
<td>-0.136</td>
<td>-0.207</td>
<td>0.131</td>
<td>-0.099</td>
<td>0.180</td>
<td>0.162</td>
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<tr>
<td>MCQ – 30 Unc</td>
<td>-0.179</td>
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<td>0.081</td>
<td>0.214</td>
<td>-0.161</td>
<td>-0.099</td>
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<td>MCQ – 30 Need</td>
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<td>-0.193</td>
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<td>-0.004</td>
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<tr>
<td>MCQ - A</td>
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<td>0.111</td>
<td>0.022</td>
<td>0.089</td>
<td>0.044</td>
<td>0.074</td>
</tr>
</tbody>
</table>

*Note. N=76. WBSI-AT = White Bear Suppression Inventory for Alcohol Related Thoughts; MCQ-30 = Metacognitions Questionnaire – 30; MCQ – 30 Cog = Metacognitions Questionnaire – 30 cognitive confidence scale; MCQ – 30 Pos = Metacognitions Questionnaire – 30 positive beliefs about worry scale; MCQ – 30 Self = Metacognitions Questionnaire – 30 cognitive self-consciousness scale; MCQ – 30 Unc = Metacognitions Questionnaire – 30 negative beliefs about thoughts concerning uncontrollability and danger scale; MCQ – 30 Need = Metacognitions Questionnaire – 30 need to control thoughts scale; MCQ – A = Metacognition Questionnaire for Alcohol Abusers; CPTIP = Continuous Performance Tests – Identical Pairs; WCST = Wisconsin Card Sorting Test – Perseverative Errors; PASAT = Paced Auditory Serial Addition Test; TRAILS-A = Trail-Making Test A; TRAILS-B = Trail-Making Test B; Alc-Stroop = Alcohol Stroop Interference Score. * p < .05, ** p < .01, two-tailed.*
<table>
<thead>
<tr>
<th>Measure</th>
<th>QIDS</th>
<th>STICSA</th>
<th>STICSA-Som</th>
<th>STICSA-Cog</th>
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</thead>
<tbody>
<tr>
<td>WBSI – AT</td>
<td>0.362*</td>
<td>0.404**</td>
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<td>MCQ - 30</td>
<td>0.621**</td>
<td>0.665**</td>
<td>0.693**</td>
<td>0.480**</td>
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<tr>
<td>MCQ – 30 Cog</td>
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<td>0.568**</td>
<td>0.537**</td>
<td>0.491**</td>
</tr>
<tr>
<td>MCQ – 30 Pos</td>
<td>0.252**</td>
<td>0.315**</td>
<td>0.358**</td>
<td>0.184*</td>
</tr>
<tr>
<td>MCQ – 30 Self</td>
<td>0.207*</td>
<td>0.168</td>
<td>0.223*</td>
<td>0.052</td>
</tr>
<tr>
<td>MCQ – 30 Unc</td>
<td>0.608**</td>
<td>0.575**</td>
<td>0.582**</td>
<td>0.441**</td>
</tr>
<tr>
<td>MCQ – 30 Need</td>
<td>0.385**</td>
<td>0.493**</td>
<td>0.502**</td>
<td>0.347**</td>
</tr>
<tr>
<td>MCQ - A</td>
<td>0.405**</td>
<td>0.489**</td>
<td>0.420**</td>
<td>0.486**</td>
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</tbody>
</table>

**Note.** N=119. WBSI-AT = White Bear Suppression Inventory for Alcohol Related Thoughts; MCQ-30 = Metacognitions Questionnaire – 30; MCQ – 30 Cog = Metacognitions Questionnaire – 30 cognitive confidence scale; MCQ – 30 Pos = Metacognitions Questionnaire – 30 positive beliefs about worry scale; MCQ – 30 Self = Metacognitions Questionnaire – 30 cognitive self-consciousness scale; MCQ – 30 Unc = Metacognitions Questionnaire – 30 negative beliefs about thoughts concerning uncontrollability and danger scale; MCQ – 30 Need = Metacognitions Questionnaire – 30 need to control thoughts scale; MCQ – A = Metacognition Questionnaire for Alcohol Abusers; STICSA = State-Trait Inventory of Cognitive and Somatic Anxiety; STICSA – Cog = State-Trait Inventory of Cognitive and Somatic Anxiety – cognitive anxiety scale; STICSA – Som = State-Trait Inventory of Cognitive and Somatic Anxiety – somatic anxiety scale; QIDS = Quick Inventory of Depressive Symptomatology – Self Report 16. * p < .05, ** p < .01, two-tailed.
Table 17

Summary of Point-Biserial Correlations Between Family History and Attention and Alcohol Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>FH</th>
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</thead>
<tbody>
<tr>
<td>CPTIP</td>
<td>-.023</td>
</tr>
<tr>
<td>WCST</td>
<td>-.013</td>
</tr>
<tr>
<td>PASAT</td>
<td>.193*</td>
</tr>
<tr>
<td>TRAILS-A</td>
<td>-.102</td>
</tr>
<tr>
<td>TRAILS-B</td>
<td>-.173</td>
</tr>
<tr>
<td>Alc-Stroop</td>
<td>.210*</td>
</tr>
<tr>
<td>ACE</td>
<td>.071</td>
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<tr>
<td>OCDS</td>
<td>.237**</td>
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</table>

*Note. FH = Family History of Alcohol Abuse; CPTIP = Continuous Performance Tests – Identical Pairs; WCST = Wisconsin Card Sorting Test – Perseverative Errors; PASAT = Paced Auditory Serial Addition Test; TRAILS-A = Trail-Making Test A; TRAILS-B = Trail-Making Test B; Alc-Stroop = Alcohol Stroop Interference Score; ACE = Alcohol Craving Experience Questionnaire; OCDS = Obsessive Compulsive Drinking Scale. * $p < .05$, ** $p < .01$, one-tailed.
Table 18

Univariate Effects for Craving Group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Levene’s $F_{(1,117)}$</th>
<th>Levene’s $p$</th>
<th>ANOVA’s $F_{(1,117)}$</th>
<th>ANOVA’s $p^†$</th>
<th>ANOVA’s $η^2_p$</th>
<th>High Craving $M$</th>
<th>High Craving $SD$</th>
<th>Low Craving $M$</th>
<th>Low Craving $SD$</th>
</tr>
</thead>
<tbody>
<tr>
<td>QIDS</td>
<td>.117</td>
<td>.733</td>
<td>3.685</td>
<td>.028</td>
<td>.031</td>
<td>6.53</td>
<td>4.088</td>
<td>5.00</td>
<td>3.945</td>
</tr>
<tr>
<td>STICSA</td>
<td>.297</td>
<td>.587</td>
<td>11.142</td>
<td>&lt;.001</td>
<td>.087</td>
<td>37.28</td>
<td>8.508</td>
<td>31.08</td>
<td>9.615</td>
</tr>
<tr>
<td>MCQ-30 Pos</td>
<td>.144</td>
<td>.705</td>
<td>.580</td>
<td>.224</td>
<td>.005</td>
<td>9.50</td>
<td>3.317</td>
<td>8.98</td>
<td>3.503</td>
</tr>
<tr>
<td>MCQ-30 Self</td>
<td>4.542</td>
<td>.035</td>
<td>5.648</td>
<td>.009</td>
<td>.046</td>
<td>18.69</td>
<td>4.084</td>
<td>16.35</td>
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<tr>
<td>MCQ-30 Need</td>
<td>.039</td>
<td>.845</td>
<td>5.700</td>
<td>.009</td>
<td>.046</td>
<td>13.00</td>
<td>4.050</td>
<td>11.11</td>
<td>3.935</td>
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<td>ACE-S Img</td>
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<td>&lt;.001</td>
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<td>ACE-F Img</td>
<td>18.675</td>
<td>&lt;.001</td>
<td>29.794</td>
<td>&lt;.001</td>
<td>.203</td>
<td>16.08</td>
<td>1.552</td>
<td>5.94</td>
<td>1.022</td>
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</table>

Note. $N=119$. Based on results from MANOVA comparing high and low craving on dependent variables (Wilks’ Lambda = .726, $F (11, 107) = 3.573, p < .001$, one-tailed). WBSI-AT = White Bear Suppression Inventory for Alcohol Related Thoughts; MCQ – 30 Cog = Metacognitions Questionnaire – 30 cognitive confidence scale; MCQ – 30 Pos = Metacognitions Questionnaire – 30 positive beliefs about worry scale; MCQ – 30 Self = Metacognitions Questionnaire – 30 cognitive self-consciousness scale; MCQ – 30 Unc = Metacognitions Questionnaire – 30 negative beliefs about thoughts concerning uncontrollability and danger scale; MCQ – 30 Need = Metacognitions Questionnaire – 30 need to control thoughts scale; MCQ – A = Metacognition Questionnaire for Alcohol Abusers; STICSA = State-Trait Inventory of Cognitive and Somatic Anxiety; QIDS = Quick Inventory of Depressive Symptomatology – Self Report 16; ACE-S Img = Alcohol Craving Experience – Strength of Imagery; ACE-F Img = Alcohol Craving Experience – Frequency of Imagery. $^†$One-tailed.
### Table 19

*Hierarchical Multiple Regression Analysis Predicting Craving Imagery Elaboration with Attention and Working Memory*

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE</th>
<th>β</th>
<th>t</th>
<th>p</th>
<th>F</th>
<th>adj. R²</th>
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</thead>
<tbody>
<tr>
<td><strong>Block 1</strong></td>
<td></td>
<td></td>
<td></td>
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<td>.193</td>
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<tr>
<td>CPTIP</td>
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<tr>
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<td>Alc-Stroop</td>
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<tr>
<td>FTQ</td>
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<td>-.683</td>
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<td><strong>Block 2</strong></td>
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<td>.013</td>
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<td>CPTIP x FTQ</td>
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<tr>
<td>WCST x FTQ</td>
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<td>.728</td>
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</tr>
<tr>
<td>PASAT x FTQ</td>
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<tr>
<td>TRAILS-A x FTQ</td>
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<tr>
<td>Alc-Stroop x FTQ</td>
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<td>109.212</td>
<td>.060</td>
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<td>.393</td>
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</table>

*Note.* N=76. CPTIP = Continuous Performance Tests – Identical Pairs; WCST = Wisconsin Card Sorting Test – Perseverative Errors; PASAT = Paced Auditory Serial Addition Test; TRAILS-A = Trail-Making Test A; TRAILS-B = Trail-Making Test B; Alc-Stroop = Alcohol Stroop Interference Score; FTQ = Family Tree Questionnaire. All predictors were mean centered. Family history of alcohol abuse was explored as a moderator in the relationship between attention/working memory and craving experience in Model 2 based on previous findings by Yates (2011). One-tailed.
Table 20

*Exploratory Hierarchical Multiple Regression Analysis Predicting Craving with All Study Variables*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1</th>
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<tbody>
<tr>
<td></td>
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<td>SE B</td>
<td>β</td>
<td>B</td>
<td>SE B</td>
<td>β</td>
<td>B</td>
<td>SE B</td>
<td>β</td>
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<td>SE B</td>
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<td>-.268</td>
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<td>ACE-S Int</td>
<td></td>
<td></td>
<td>.932</td>
<td>.286</td>
<td>.648</td>
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<tr>
<td>ACE-F Img</td>
<td>.055</td>
<td>.122</td>
<td>.094</td>
<td></td>
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<tr>
<td>ACE-F Int</td>
<td>-.570</td>
<td>.312</td>
<td>-.399</td>
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</table>

| $R^2$            | .110    | .310     | .527     |          |          |          |          |          |          |          |          |
| Adj. $R^2$       | .073    | .227     | .437     |          |          |          |          |          |          |          |          |
| $F$              | 2.973   | 3.759*   | 5.842**  |          |          |          |          |          |          |          |          |
| $R^2$ change     | .110    | .200     | .217     |          |          |          |          |          |          |          |          |
| $F$ for change in $R^2$ | 2.973 | 3.875** | 7.216**  |          |          |          |          |          |          |          |          |

*Note. N=76. FH = family history from the Family Tree Questionnaire; CPT-IP = Continuous Performance Task – Identical Pairs Version; Alc-Stroop = alcohol stroop interference score; QIDS = Quick Inventory of Depressive Symptomatology; STICSA = State-Trait Inventory for Cognitive and Somatic Anxiety; MCQ-30 = Metacognitions Questionnaire – 30; MCQ-A = Metacognitions Questionnaire for Alcohol; WBSI-AT = White Bear Suppression Inventory for Alcohol Related Thoughts; ACE-S Img = Alcohol Craving Experience – Strength of Imagery; ACE-S Int = Alcohol Craving Experience – Strength of Intrusions; ACE-F Img = Alcohol Craving Experience – Frequency of Imagery; ACE-F Int = Alcohol Craving Experience – Frequency of Intrusions. *$p < .01$, **$p < .001$, two-tailed.*
APPENDIX A

INSTITUTIONAL REVIEW BOARD INFORMED CONSENT FORM
Before agreeing to participate in this research study, it is important that you read and understand the following explanation of the purpose, benefits and risks of the study and how it will be conducted.

**Title of Study:** Attention and Metacognition in the Elaborated Intrusion Theory of Desire

**Investigator:** Craig Neumann, Ph.D, University of North Texas (UNT) Department of Psychology.

**Purpose of the Study:** You are being asked to participate in a research study that examines alcohol use, alcohol craving-related thoughts, anxiety, depression, and family history of alcohol use. Additionally, this study examines attention and working memory performance and how performance in this area is related to craving for alcohol.

**Study Procedures:** You will be asked to complete ten questionnaires related to alcohol use, anxiety, and depression. Additionally, you may be asked to complete five tests of attention and working memory. This will take about two hours of your time.

**Foreseeable Risks:** No foreseeable risks are involved in this study.

**Benefits to the Subjects or Others:** This study is not expected to be of any direct benefit to you, but we hope to learn more about how craving for alcohol works. This information may be beneficial in developing treatments for alcohol abuse, or in understanding the components of craving.

**Compensation for Participants:** None

**Procedures for Maintaining Confidentiality of Research Records:** No personally identifiable information related to your participation will be stored. Additionally, the information you provide while completing the study will not be linked to your identity. All information will be kept in a locked file cabinet in a locked room. The confidentiality of your individual information will be maintained in any publications or presentations regarding this study.

**Questions about the Study:** If you have any questions about the study, you may contact Craig Neumann at craig.neumann@unt.edu or Robert Yates at rdy0009@unt.edu

**Review for the Protection of Participants:** This research study has been reviewed and approved by the UNT Institutional Review Board (IRB). The UNT IRB can be contacted at (940) 565-3940 with any questions regarding the rights of research subjects.
**Research Participants’ Rights:**  
Your signature below indicates that you have read or have had read to you all of the above and that you confirm all of the following:

- *Craig Neumann or a designated research assistant* has explained the study to you and answered all of your questions. You have been told the possible benefits and the potential risks and/or discomforts of the study.
- You understand that you do not have to take part in this study, and your refusal to participate or your decision to withdraw will involve no penalty or loss of rights or benefits. The study personnel may choose to stop your participation at any time.
- You understand why the study is being conducted and how it will be performed.
- You understand your rights as a research participant and you voluntarily consent to participate in this study.
- You have been told you will receive a copy of this form.

______________________________  
Printed Name of Participant

______________________________  
Signature of Participant  __________________  
Date

**For the Investigator or Designee:**  
I certify that I have reviewed the contents of this form with the subject signing above. I have explained the possible benefits and the potential risks and/or discomforts of the study. It is my opinion that the participant understood the explanation.

______________________________  
Signature of Investigator or Designee  __________________  
Date
APPENDIX B

DEMOGRAPHICS QUESTIONNAIRE
How old are you_________________

Circle the Race/Ethnicity that best describes you.
White/Caucasian          Black/African American     Asian  Hispanic    Native American    Other

Have you ever been in an accident where you hit your head and were unconscious for more than 2 minutes?    Yes  No

*Have you ever been told that you have a developmental disorder such as: Autism, Mental Retardation, Rett’s Disorder, Childhood Disintegrative Disorder, or Asperger’s Disorder?    Yes  No

Do you drink alcohol?    Yes  No

Do you use drugs other than alcohol?    Yes  No

*Are you currently taking any psychoactive medications such Ritalin, anti-anxiety medications, anti-depressants, seizure disorder medication, or anti-psychotics?    Yes  No

If you drink, at what age did you begin drinking? ________________

How many alcoholic beverages do you consume during a typical week? ________________

If you have recently stopped drinking, how long has it been since your last drink? ____________
REFERENCES


