

INDIVIDUAL DIFFERENCES IN THE ATTENTIONAL BLINK
TO ALCOHOL RELATED CUES

by

Francesco M. DePalma, B.A.

A thesis submitted to the Graduate Council of
Texas State University in partial fulfillment
of the requirements for the degree of
Master of Arts
with a Major in Psychological Research
May 2016

Committee Members:

Reiko Graham, Chair

Natalie Ceballos

Logan Trujillo

COPYRIGHT

by

Francesco M. DePalma

2016

FAIR USE AND AUTHOR'S PERMISSION STATEMENT

Fair Use

This work is protected by the Copyright Laws of the United States (Public Law 94-553, section 107). Consistent with fair use as defined in the Copyright Laws, brief quotations from this material are allowed with proper acknowledgement. Use of this material for financial gain without the author's express written permission is not allowed.

Duplication Permission

As the copyright holder of this work I, Francesco DePalma, authorize duplication of this work, in whole or in part, for educational or scholarly purposes only.

ACKNOWLEDGEMENTS

I would like to thank my mentor and supervisor, Dr. Graham, for the incalculable amount of time spent with me both inside and outside of the lab, as well as her willingness to provide me with the best mentorship, guidance, and knowledge possible during my time at Texas State – for this I am eternally grateful. I would also like to thank my other thesis committee members, Dr. Ceballos and Dr. Trujillo, for their invaluable feedback and guidance along the different stages of my thesis development. I'd also like to thank John Treffalls for helping out with data collection and data processing. Most importantly, I thank my parents, who have been unrelenting in their support, love, and encouragement since day one.

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS.....	iv
LIST OF FIGURES	vi
LIST OF ABBREVIATIONS.....	vii
ABSTRACT.....	viii
CHAPTER	
I. INTRODUCTION	1
II. LITERATURE REVIEW	6
Addiction and Alcohol Abuse.....	7
Attentional Bias in Alcohol Use/Abuse.....	8
Attentional Blink.....	13
Hypotheses and Rationale.....	17
III. RESEARCH METHODS & DESIGN.....	19
Participants.....	19
Stimuli: AB Task Version 1 (words)	19
Stimuli: AB Task Version 1 (images).....	20
AB Task	20
Self-Report Measures.....	21
Procedure	22
IV. RESULTS	23
V. DISCUSSION	30
REFERENCES	43

LIST OF FIGURES

Figure	Page
1. Main effect of lag on overall T2 accuracy	25
2. T2 target type x lag interaction	26
3. Image-based experiment: lag x family history interaction	26
4. Word-based experiment: lag x family history interaction	27
5. The interaction between T2 target type and drinking group for the word-based task version	29
6. The interaction between T2 target type and drinking group for the image-based task version.....	29

LIST OF ABBREVIATIONS

Abbreviation	Description
AB	Attentional Blink
ANOVA	Analysis of Variance
AUD	Alcohol Use Disorder
ERP	Event-related Potential
NIAAA	National Institute on Alcohol Abuse and Alcoholism
QFI	Quantity Frequency Index
RSVP	Rapid Serial Visual Presentation
RT	Reaction Time
SOA	Stimulus Onset Asynchrony
WHO	World Health Organization

ABSTRACT

Research examining attentional biases toward alcohol cues in social drinking populations has relied on several different attentional paradigms, the majority of which do not provide researchers with insight on the temporal dynamics (e.g., early or late stages of processing) of these biases. The purpose of this study was to investigate the temporal dynamics of these biases in social drinkers of alcohol using an attentional blink (AB) paradigm. Male and female social and abstinent drinkers were recruited to complete one of two AB tasks (i.e., words or images). It was predicted that heavier social drinkers would show a reduced AB relative to lighter drinkers and abstainers, indicative of more efficient processing of alcoholic stimuli at early levels of encoding. It was also predicted that a family history of problem drinking will enhance this effect. Additionally, the AB to words and images was compared to explore the role of stimulus type on attentional capture. Our results show a reduced AB for alcohol-related images, but not words, in heavier social drinkers at early levels of encoding, suggesting a more efficient processing of alcohol-related images in this group. Further, family history of alcohol problems did not modulate the AB effect. These results of attentional bias may help inform AUD treatment options, as well as assessment of an individual's risk for developing an AUD.

I. INTRODUCTION

According to the World Health Organization (WHO, 2014), global alcohol use has a substantial impact on multiple facets of society, including social, economic, and disease-associated burdens. Approximately 40% of the global population over the age of 15 has engaged in alcohol consumption in the past year, 16% of which engaged in heavy consumption (> 25 drinks per week; WHO, 2014). In 2012, 3.3 million deaths (globally) were directly attributable to alcohol use (WHO, 2014). Given that these negative outcomes are avoidable, understanding why individuals progress to problem drinking has important implications for the treatment and prevention of alcohol use disorders (AUDs).

A variety of factors, including biological, genetic, environmental and social factors make significant contributions to the development of problem drinking, and ultimately AUDs. Individual differences (e.g., personality, gender) as well as different developmental environments can have a substantial impact on rates of alcohol consumption and frequencies, as well as the complications that can arise from problem drinking (Cloninger, 1987). Specifically, the abuse of alcohol in earlier years of life (e.g., early teenage years) has been shown to increase the likelihood of an AUD manifesting itself as alcohol consumption and abuse continues into adulthood (Grant & Dawson, 1997). Not only can sustained use and abuse of alcohol lead to health problems and the development of an AUD, it also leads to other negative outcomes, such as adolescent and young adult morbidity. Early alcohol abuse can be directly responsible and associated with fatal motor vehicle crashes (Millstein & Irwin, 1988), an increased likelihood of tobacco and other drug use (Schuckit & Russel, 1983), as well as increased sexual activity and an increased likelihood of sexually transmitted diseases, violence, and

depression (Grant & Dawson, 1997). Although these consequences are more likely in younger drinkers, they can affect drinkers of any age.

Because of the many potential negative consequences that can result from unhealthy patterns of alcohol use, it is important for researchers to provide insight into the differences that place individuals at risk for AUDs, as well as behavioral and biological correlates of these risk factors. Many studies in the realm of alcohol research have focused on understanding the cognitive and neural aspects of use and abuse, attentional mechanisms in particular. Attention allocation partially depends on how personally relevant a particular stimulus is to that person, often resulting in an attentional bias (i.e., automatic shifting of attentional resources; Ohman, 1993) toward stimuli that are motivationally significant (Cisler, Bacon, & Williams, 2009). Past research has shown consistently that an attentional bias toward alcohol-related cues exists in those who have an AUD, drink heavily (Johnsen et al., 1994), or engage in potentially harmful drinking patterns, such as binge drinking (Cox et al., 2002). This tendency for alcohol-related cues to capture attention in heavy drinkers is thought to be the results of repetitive alcohol use. As a result of repeated use, a craving for alcohol can be elicited by alcohol-related stimuli (e.g., visual, verbal, or situational/contextual cues). This craving can arise from a variety of factors, including negative or positive reinforcement and self-medication associated with changes in mood state (e.g., anxiety relief), which are all highly dependent on the individual. Any type of stimulus in the environment that is associated with alcohol (e.g., beer bottle, shot glass, bar) possesses *incentive salience*, in that the stimulus (or stimuli) becomes highly attractive to the user (Robinson & Berridge, 1993).

Several different paradigms have been used to study attentional biases to drug-related cues in alcohol and other drug users. Of these paradigms, Stroop tasks, dot-probe tasks, dual-tasks, and flicker-induced blindness tasks are most frequently used to assess attentional biases within the context of addiction. Although these paradigms have demonstrated the existence of attentional biases toward drug/alcohol cues, they have their shortcomings. For example, these paradigms tend to rely on reaction time differences between control and drug cues as an index of attentional bias, ultimately failing to pinpoint when the processing of these salient cues occurs. Additionally, performance on these tasks does not allow researchers to draw conclusions about the efficiency with which stimuli gain access to consciousness. Much of the research on attentional bias in drug use cannot address the temporal dynamics of attentional biases to drug-related cues. Therefore, the stages of selective attention in which these biases occur (i.e. orienting versus maintenance), are not well delineated. The AB paradigm, however, may be able to overcome these shortcomings, providing us with more nuanced information about the time course of attentional biases toward drug-related cues.

The AB was first introduced/reported by Raymond and colleagues (1992). Given two masked targets (T1 and T2) in a rapid serial visual presentation (RSVP) stream of distracter stimuli, the ability to report T2 when it followed T1 within 500 ms was significantly reduced. This is thought to occur because our attentional system has a limited capacity and there are insufficient resources to process all of the stimuli fully, thus T2 must compete with T1, in addition to intervening distracters (Chun & Potter, 1995). Tibboel, De Houwer, and Field (2010) have used this paradigm to examine attentional biases at early levels of encoding using alcohol cues and found T2

performance was significantly better when it was an alcohol-related word as opposed to soft-drink related in heavy social drinkers who drank more than 21 drinks per week (i.e., reduced attentional blink), but not in light drinkers (less than 5 drinks per week). These results suggest that heavy drinkers possess an attentional bias for alcohol-related cues. Tibboel et al. (2010) posit that these findings are indicative of more efficient processing of alcohol-related cues in heavy drinkers at early levels of encoding during a high cognitive load.

As mentioned, paradigms used to investigate attentional biases in alcohol users tend to focus on the spatial dynamics of attention (Trippe et al., 2007). Therefore, it is important to study the temporal dynamics of attention to alcoholic cues using an AB paradigm because it has the potential to clarify the time course of attention to alcohol-related cues when they compete with several other stimuli, which may provide a more nuanced account of attentional bias compared to other paradigms. Because Tibboel et al. (2010) investigated attentional bias using only consumption frequencies in heavy drinkers, it is important to determine whether other factors modulate the AB effect. For example, it is not known whether such biases exist in lighter drinkers, or whether factors associated with future problem drinking, such as family history of AUD (Dager et al., 2013), would also have an impact on this effect. The current study also included an image-based AB task version in addition to a word-based version in order to compare differences in the AB effect in pictorial vs. semantic targets, with the assumption that an image-based AB task would be more effective at capturing attention due to the fact that images more closely reflect addiction-related cues encountered in real life.

In order to understand the relationship between alcohol use/addiction and attentional biases, it is important to review the literature surrounding basic selective attention and the manifestation of addiction. A review of addiction and alcohol abuse in the context of attentional bias will then be discussed. Afterwards, a comprehensive review of the attentional paradigms that have been used to assess such biases will be provided, with justification for the use of an AB paradigm for the proposed study. The results of this study will provide insight on the temporal dynamics of attentional biases to alcoholic cues, and will also contribute to AUD intervention, prevention, and risk-assessment efforts.

II. LITERATURE REVIEW

Attention is the ability to select certain information from the environment for further processing while ignoring other, irrelevant information (Balkenius, 2000). The brain does not have the ability or capacity to process every single piece of information it receives from the sensory systems; therefore, an efficient attentional system is required in order to select stimuli for further processing (Ward, 2010). Attention can be externally guided by a stimulus (or stimuli; i.e., exogenous orienting) or, to some extent, guided by the specific goals of the perceiver (i.e., endogenous orienting). After attention is established, the object of attention is encoded, allowing the person to respond accordingly to the selectively attended stimulus (Allport, 1990).

Frequently, stimuli in the environment are motivationally-relevant to the viewer (i.e., positively or negatively valenced, or approach/avoidance related), and often have an advantage of being selectively attended to over other stimuli in the same visual field (Ohman, 1993). These attentional biases tend to occur when the particular stimulus has a greater behavioral and cognitive impact on the person relative to others in the environment (Bruce & Jones, 2006). Although innate biases exist (e.g., threat; Lee & Knight, 2009), it is often the case that attentional biases develop through learning (Le Pelley, Mitchell & Johnson, 2013). Given the idea that selective attention is one of the very first steps in coordinating a goal-oriented movement or action (Allport, 1987), it is an important factor in the manifestation and maintenance of addiction. Previous research has demonstrated the importance of attention, specifically attentional bias, in individuals with an addiction (Hester, 2006).

Addiction & Alcohol Abuse

The development of an addiction is a process, in that it does not occur spontaneously (Sussman & Sussman, 2011). Although an addiction can be formed for almost any substance or activity, alcohol abuse and AUDs are of particular concern for the proposed research. At the very start of this process, the consumer usually has some goal in mind (e.g. reduction of pain, emotional enhancement, arousal, etc.) and consumption is motivated by this goal (Goodman, 1990; Hatterer, 1982). Once alcohol consumption is initiated, it is often the case that a person will continue to consume alcohol, and over time, the frequency and amount of alcohol consumed will increase (Sussman & Sussman, 2011). Ultimately, these patterns of behavior occur more frequently, and a craving or wanting for alcohol develops (Orford, 2001). The addictive behaviors become more automatic in nature, and increasingly difficult to control (Goodman, 1990). Because of the automaticity of the addictive process over time, with repeated exposure to alcohol-related cues, aspects of cognition, particularly attention, become affected (Field, Mogg, Zetteler, & Bradley, 2004).

In addition to learning, other factors can contribute to the initiation of alcohol use and addiction. For example, genetics may play a substantial role in the development of an AUD. According to the National Institute of Alcohol Abuse and Alcoholism (NIAAA, 2008), genes account for about half of the risk of alcoholism, and having an alcoholic parent or family member greatly increases a person's odds of abusing alcohol (Sher & Slutske, 2003). Other risk factors include biological factors such as decreased frontal cortex activity (hypofrontality), which can lead to general impulsivity (Nigg, 2000), as

well as a multitude of environmental and social factors, including negative peer influences and a low socioeconomic environment (Sher et al., 2005).

Attentional Bias in Alcohol Use/Abuse

Incentive-sensitization theory, proposed by Robinson and Berridge (1993), suggests that through prolonged and repeated exposure to alcohol and associated cues, neural systems associated with reward become activated and reinforced over time. The activation of the meso-limbic and meso-cortical dopamine systems of the brain confers an incentive salience to alcohol-related cues, such that these cues are highly attractive to the user and more likely to capture attention. Over time, these stimuli become increasingly more attractive, and thus, begin to influence behavior (e.g., cravings, seeking and consuming alcohol).

Wiers et al. (2007) hypothesize that incentive salience arises from the activation of an *appetitive approach-oriented system*, wherein alcohol becomes sensitized with repeated use and leads to automatic tendencies to seek the substance (see Robinson & Berridge, 1993). The Wiers et al. (2007) model proposes that there are two main components involved in addiction – automatic processes and controlled processes. Automatic processes (i.e., implicit) recruit a fast, impulsive system which appraises stimuli automatically based on emotional and motivational significance, usually outside of conscious control. Controlled processes (i.e., explicit), however, are slower and more reflective of conscious deliberations and expected outcomes. Traditionally, explicit (self-report) measures of appetitive motivation to consume/ positive reinforcement from consumption were used to predict future alcohol use. However, Wiers et al. (2007) argue that explicit measurements have very low power in predicting future alcohol use, as these

measurements are susceptible to social desirability biases. Implicit measures of appetitive emotion, such as attentional biases for alcohol or drugs, have greater power to predict spontaneous behaviors, as they are less amenable to cognitive control. Because people are often unaware of the influence these biases have on drug-seeking behaviors, implicit measures provide a more accurate representation of appetitive motivations. The remainder of this section will review the current understanding of attentional biases toward alcohol-related stimuli as indexed by different implicit measures, culminating in the purpose and rationale of the proposed research.

Attentional biases to alcohol-related cues were assessed by Johnsen, Laberg, Cox, Vaksdal and Hugdahl (1994), who administered a modified Stroop paradigm to alcoholics using alcohol-related and non-alcohol-related words. Words were presented in different colored fonts and participants were asked to report the font color of each word as quickly as possible. Relative to an aged-matched nonalcoholic control group, alcoholics had slower RTs when naming the color of alcohol-related words as well as slower RTs for alcohol-related words relative to neutral words. These findings were thought to be due to the fact that alcohol-related words were more salient than the neutral words, most likely because of repeated exposure and experience with alcohol in alcohol dependent individuals (Johnsen et al., 1994). Thus, an increased competition between word meaning and color name manifests due to the high salience of alcohol-related words, yielding longer RTs. Subsequent studies employing modified Stroop paradigms to investigate alcohol-related attentional biases have replicated these findings in clinical populations (Stetter, Ackermann, Bizer, Straube, & Mann, 1995), social drinkers (Bruce & Jones, 2004), and heavy drinking adolescents (at least 23 drinks per week; Field,

Christiansen, Cole, & Goudie, 2007). Overall, studies employing the Stroop task confirm the existence of attentional biases toward alcohol-related stimuli in drinkers. However, they do not provide information about the temporal dynamics of these biases.

Specifically, it is uncertain whether slower reaction times to alcohol-related stimuli are due to attentional capture by or an inability to disengage attention from these stimuli.

Another commonly used paradigm used to examine attentional biases in alcohol use is the visual dot probe (or probe detection) task. Townshend and Duka (2001) used this task to examine attentional biases in heavy social drinkers. Participants were presented two images side by side: an alcohol-related image and a neutral image. These stimuli were presented simultaneously for either 200ms, 500ms, or 2000ms. After stimulus presentation, the picture pair disappeared and a probe (i.e., dot or arrow) was presented in either the position of the alcohol-related picture, or the neutral picture. Participants were asked to indicate on which side the probe was presented as quickly and accurately as possible. Attentional bias was indexed by RTs to indicate the position of the probe as a function of whether it appeared in the same position as the alcohol image relative to when it appeared in the same position as the neutral image. Townshend and Duka (2001) found that relative to occasional social drinkers, heavy alcohol drinkers were faster to indicate the probe position when it replaced the alcohol image, indicative of an attentional bias for alcohol-related stimuli. Field, Mogg, Zetteler, and Bradley (2004) replicated this study and found nearly identical results. These results were also comparable to those found in visual probe tasks for cigarette smokers using smoking-related stimuli (Ehrman et al., 2002; Bradley et al., 2003), as well as opiate users (Lubman et al., 2000). According to Field et al. (2004), these results suggest the

existence of attentional biases to drug-related cues in the maintenance stage of attention. However, while these results support the existence of attentional biases toward alcohol in drinkers, they do not provide evidence of an attentional bias in the initial orienting stages of attention.

Attentional bias in alcohol users can also be assessed using a dual-task paradigm. Waters and Green (2003) designed a study comparing alcohol abusers (both abstinent and continuing) and a control group performing two tasks. In this task, a number was centrally-presented on a computer screen, and participants were asked to indicate whether the number was odd or even. At the same time, an alcohol-related, neutral, or non-word was presented on the screen in their peripheral visual field (i.e., lexical decision task). Participants were also asked to identify the peripheral word as either a word or non-word. They found that alcohol abusers performed worse than the control group on the odd/even task when an alcohol-related word was presented in their peripheral visual field. Their reactions times were also slower for making a lexical decision when the peripheral word was alcohol-related. These results may suggest an interference effect, as the alcohol abusers may have directed their attention toward the alcohol-related cues, which in turn, interfered with the odd/even task. However, Field and Cox (2008) provide another possible interpretation of the results, with particular regard to the abstinent alcohol abusers. Alcohol abusers who were currently abstinent may not have been selectively attending to the alcohol-related stimuli, but rather trying to avoid it, which may have interfered with odd/even task performance. Therefore, these results do not clearly elucidate how attention is influenced by the alcohol-related stimuli.

Another less commonly used paradigm to assess attentional biases is the flicker-induced change blindness paradigm (Jones et al., 2002), wherein two scenes are presented in a rapid succession. The scenes differ slightly, in that some things are added or removed (e.g., drug-related changes or changes to non-drug related aspects of a scene). Participants were presented these scenes until they could accurately detect the change. Jones et al. (2002) found that active drug users were able to detect scene changes more quickly when the changes were drug-related relative to non-drug related scene changes, suggesting that participants were allocating their attention toward the drug-related objects in a scene, making it easier to detect changes. However, similar to other paradigms discussed previously, these results fail to provide insight on the temporal dynamics (e.g. initial orienting or maintenance) of attention and how these contribute to alcohol-related biases.

In summary, although the results from the above-mentioned paradigms have shown an attentional bias toward alcoholic/drug cues to exist, they fail to inform us about whether such biases are due to increased efficiency of attentional processing at early levels of encoding or an inability to disengage attention from alcohol-related stimuli. The AB paradigm, however, may provide substantive insight on the existence of attentional biases during the initial orienting stages of attention. It also has the ability to allow researchers to examine more closely the limited capacity of the human attentional system, and to what extent stimuli need attentional resources to reach consciousness (Tibboel et al., 2010).

Attentional Blink

The AB phenomenon was first described by Raymond, Shapiro and Arnell (1992). The AB was observed by presenting participants a first target (T1) followed by a second target (T2) some position (i.e., lag) after T1 amongst a number of distracter stimuli in a RSVP stream. Raymond et al. (1992) found that when T2 was presented within 100-500 ms of T1, participants had significant deficits in T2 identification. This deficit in attentional processing was appropriately named an AB. The AB phenomenon occurs only in this specific temporal window, with T2 performance recovering after approximately 500 ms. As a result, Raymond et al. (1992) suggested that the AB occurred during the early levels of attentional processing. They argued that during an RSVP stream, T1 is detected pre-attentively (i.e., unconsciously). This pre-attentive information is then used to encourage and facilitate T1 identification. This model also suggests that attention may be allocated episodically, in that the episode of attention begins with target detection and ends with target identification. An attentional episode tends to be short-lived and the availability of attentional resources is highly limited. After these attentional resources are recruited for T1 detection and identification, the ability for the attentional system to detect subsequent stimuli is temporarily diminished. In other words, it takes time for the attentional system to recover so that resources can be directed to the identification of T2 (approximately 500 ms after T1 presentation). Ultimately, the data from Raymond et al. (1992) suggests that during a highly demanding attentional task, the resources engaged in T1 identification cause the underlying attentional mechanisms “blink”, such that subsequent stimuli are not fully encoded until attention has time to recover and begin a new “episode”.

Chun and Potter (1995) have proposed a two-stage model for the AB, consisting of a preattentive stage and a more deliberative, capacity-limited stage. The first stage, or *rapid detection stage*, is assumed to be relatively short-lived, and involves more pre-attentive processes. Chun and Potter (1995) argue that when each item is presented for the same duration in the stream, virtually every item is processed pre-attentively during this stage. A person's pre-attentive system scans each item searching for the proposed target (i.e., T1) using categorical or specific cues to identify the target. For example, if the participant is told that the target is a white letter, font color is the identifying cue as part of the stream analysis. Chun and Potter (1995) suggest that in an RSVP stream rate of about ten items per second, the categorical identity (e.g., font color), and perhaps specific identity (e.g., letter), of each item is momentarily available for further processing via selective attention.

The second stage is referred to as the *capacity-limited processing* stage, wherein an identification made in the first stage is selected for additional processing in order to fully identify and report the target (Chun & Potter, 1995). A potential target item must be represented in a way that allows the person to report the target at the end of the stream (e.g., reach short term memory). In order for this to occur, a target (or targets) must be fully identified and consolidated, while filler items in the RSVP stream are discarded. Identification and consolidation of the first target beyond stage one is very likely. However, if T1 is still recruiting second-stage processing when T2 appears, the likelihood of detecting and processing T2 is reduced greatly. The shorter the delay (i.e., the closer T2 is to T1 in the RSVP stream), the higher the probability of an attentional blink.

It is important to note that this recovery interval can vary depending upon the nature of T2. For example, if T2 shares processing resources with T1 (i.e., target-target similarity), there tends to be a more severe deficit in the ability to report T2 (i.e., a larger AB) than dissimilar T1 and T2 targets (Awh et al., 2004). Awh et al. (2004) suggests that when T1 and T2 are similar, T1 processing occupies the necessary resources needed to discriminate and report T2 at short lags. Essentially, the magnitude of the AB increases as the overlap of processing requirements between T1 and T2 increases (Sy & Giesbrecht, 2009). As mentioned previously, stimuli vary in their motivational significance, which can result in attentional biases. Thus, when T2 is highly salient (e.g., one's own name or other motivationally-relevant stimulus), the AB will be attenuated (i.e., higher T2 identification rates at short lags; Shapiro, Caldwell, & Sorensen, 1997). Because the AB is thought to be indicative of attentional competition between the RSVP items, particularly in the early stages of attention, using an AB task can be useful in understanding the underlying attentional biases in substance use and abuse (Tibboel, De Houwer, & Field, 2010). Other attentional paradigms mentioned earlier provide evidence supporting the existence of attentional bias in substance abusers for drug related cues, but fail to show the specific attentional statuses of substance-related stimuli at early levels of encoding. The AB paradigm allows researchers to observe the time course of attention, by limiting available attentional resources by using short temporal lags between target items among an RSVP stream. These manipulations are necessary in order to examine whether alcohol-related stimuli are processed more efficiently at early levels of encoding than non-alcoholic stimuli.

A few studies have examined the AB in substance abusers using a neutral T1, random distracter items, and either a substance-related or control T2 stimulus. Cigarette smokers have shown to have a smaller AB (i.e., higher T2 identification rates) for nicotine/smoking-related words relative to control words (Waters, Heishman, Lerman, and Pickworth, 2007). A similar reduction in the AB to opiate-related words has also been observed with opiate-dependent patients (Liu, Li, Sun, & Ma, 2008). Most relevant to the proposed research, a study by Tibboel et al. (2010) is one of the only studies that utilized the AB paradigm to assess attentional biases in alcohol drinkers. The purpose of their study was to determine whether alcohol-related T2 words were processed more efficiently than neutral soft drink-related words in heavy drinkers (> 21 drinks/week) versus light social drinkers (<5 drinks/week). Overall, the heavy drinking group had a reduced AB for alcohol-related words compared with soft drink-related words, suggestive of more efficient processing of alcohol-related words at early levels of encoding, as well as an attentional bias for alcohol-related stimuli. The light drinkers showed an equally strong AB for both word types, suggesting an attentional bias for alcohol-related words does not exist in this group. Given that this was the only AB study in the literature involving alcohol, it was important to continue using this paradigm to assess the attentional biases associated with social alcohol consumption in college drinkers. Understanding attentional biases in college-aged social drinkers is especially important, in that it may identify putative risk factors for future problem drinking, such as family history of problem drinking. Additionally, the effect of target type (word vs. image) on the AB effect was examined by using a word-based and image-based task, as Tibboel et al. (2010) used only word-based stimuli. The use of an AB paradigm allowed for the

examination of the attentional status of alcohol-related cues (words vs. pictures) at early levels of encoding, as well as examined how efficiently these cues are processed.

Hypotheses and Rationale

The primary aim of this study was to examine whether alcohol-related stimuli were processed more efficiently at early levels of encoding than non-alcoholic stimuli, and if this phenomenon was modulated by alcohol consumption patterns in college students. Based on the results of Tibboel et al. (2010), it was hypothesized that heavier social drinkers (i.e., total QFI > 0.5) would have greater accuracy in categorizing alcohol-related stimuli compared to lighter (i.e., total QFI < 0.5, but > 0) or abstinent drinkers (total QFI = 0). The above QFI group cut-offs were different than those used in Tibboel et al. (2010) and is explained further below in Section III. Greater accuracy for alcohol-related T2 stimuli was evidenced by an attenuated AB. Additionally, it was hypothesized that the heavier social drinkers would have a larger AB effect for the non-alcoholic stimuli, with the lighter and abstinent drinkers possessing a strong AB for both types of stimuli.

A secondary aim was to explore individual differences that may moderate the magnitude of the AB effect, such as family history of alcohol-related problems. It was hypothesized that participants with a positive family history of alcohol problems would have attenuated ABs for alcohol-related stimuli, as prior research shows greater cue reactivity to alcohol-related stimuli in individuals with a positive family history, independent of personal consumption (Dager et al., 2013).

The final aim of the study was to compare the effectiveness of word-based and image-based AB tasks (alcohol-related vs. non-alcohol-related words vs. images). This

aim was motivated by the fact that AB paradigms differ with respect to the stimuli used as targets (i.e., words or images). However, it is possible that target parameters could influence results on AB tasks, especially those employing addiction-related (or other motivationally relevant) stimuli. On one hand, words and images are thought to share common neural substrates (e.g., Vandenberghe et al., 1996). If this was the case, then the AB to alcohol-related images should have been similar to that for words. On the other hand, visual stimuli have greater ecological validity, as they are more likely to be cues encountered in everyday life. In this case, T2 images of alcoholic beverages should have captured attention more efficiently in heavier social drinkers, which would have resulted in an attenuation of the AB relative to non-alcoholic targets.

III. RESEARCH DESIGN AND METHODS

Participants

Participants were recruited from the Psychology Department at Texas State University and had normal or corrected-to-normal vision. The participant sample consisted of 142 college students over the age of 18, seventy-three completed the word version of the AB task and sixty-nine completed the image version. Compensation for participation was in the form of course credit for an introductory-level Psychology course via the Texas State Psychology Department's online human subjects pool (SONA). Procedures were approved by the Institutional Review Board at Texas State University.

Stimuli: AB Task Version 1 (words)

The design of the word version of the AB task was based primarily on the AB study conducted by Tibboel et al. (2010). Thirteen neutral distracter words were selected from a word list used in a study by Anderson (2005) that were long enough to effectively mask the two targets. The first target (T1) had two different types of neutral stimuli: kitchen gadgets or office supplies. Six of the possible T1 words were kitchen gadgets and the other six possibilities were office supplies, for a total of twelve neutral T1 target words. The second target (T2) also had two different types of stimuli: alcohol-related words and soft-drink related words, also with six words per type. Distracter words were presented in black 20-point font, while both T1 and T2 were presented in green 20-point font (indicating target status) against a white background. Distracter words subtended approximately 2.01° visual angle horizontally and 0.50° vertically. Target words subtended approximately 1.51° visual angle horizontally and 0.50° vertically.

Stimuli: AB Task Version 2 (images)

The second version of the AB task was identical to version 1, only with images used as stimuli in lieu of words. For the neutral distracters, 13 nonsensical colored shapes (DeSchepper & Treisman, 1996) were used. For the T1 and T2 stimuli, the images were surrounded by a green border, indicating their target status. The T1 stimuli were 6 kitchen gadget images (e.g., spoon) and 6 office supply images (e.g., stapler). The T2 stimuli were 6 alcohol-related images (e.g., beer bottle) and the other 6 were non-alcoholic images (e.g., soda bottle). Distracter images subtended approximately 6.03° visual angle both horizontally vertically. Target images subtended approximately 7.06° visual angle both horizontally and vertically.

AB Task

Participants completed one of two versions of the AB task. Both AB task versions were identical except for the stimuli used (i.e., words or images). The task involved the viewing of an RSVP stream filled with distracter words or images and two target words or images, in which the participants were asked to categorize the two targets after the RSVP presentation.

Within the 15-item RSVP stream, the position of T1 was variable. T1 either appeared at the third, fourth, or fifth position in the stream, with all positions appearing an equal number of times in the experiment. The position in which T2 followed T1 (i.e., lag) was also variable. T2 appeared either 2, 4, or 6 lags away from T1, reflecting SOAs of 220, 440, and 660 ms respectively. There were 12 presentations of each T2 at each of the lags and each of the possible T1 positions, resulting in 216 total experimental trials. The different types of trials were randomly presented.

AB tasks were created using Superlab 2.0 (Cedrus, San Pedro CA; Version 1, words) and Superlab 5.0 (Cedrus, San Pedro CA; Version 2, images). Each participant completed 10 practice trials and 216 experimental trials. At the beginning of each trial, a black fixation cross was presented on a white screen for 1000 ms. Following the fixation cross, an RSVP stream was presented with 13 neutral distracter stimuli, and T1 and T2. The stimuli were each presented for 100 ms with an ISI of 10 ms. After the stream was complete, a response screen appeared. On the response screen, the participants were asked to categorize T1 as a kitchen gadget or an office supply by pressing the appropriately corresponding key. For example, pressing the “1” key indicated a kitchen gadget, and pressing the “2” key indicated an office supply. A second response screen appeared afterwards, with the same procedure as the T1 categorization, but required a T2 categorization – alcohol or non-alcohol (i.e., soft-drink). T1 categorization always preceded T2 categorization for all trials across all participants. Following this response screen, the participants were then required to press a key to move on to the next trial, giving them the opportunity to take a break at any point in between trials, in order to minimize possible boredom or fatigue.

Self-report measures

Upon completion of the AB task, the participants then filled out an online survey consisting of questions to determine basic demographics, alcohol consumption frequencies of the last 6 months and family history of alcohol problems.

Absolute ounces of alcohol consumed by the participant in the six months prior to testing was determined using a quantity/frequency index (QFI; Cahalan et al., 1969). Participants indicated the amount of alcohol consumed (in ounces), the type/proof of

alcohol, and the frequency of consumption (e.g., daily, 5-6 times/week, etc.). Frequencies were assigned a Jessor weight for the calculation (e.g., 1.00 = daily, .80 = 5-6 days/week, .00 = none). The QFI calculations multiplied the above three factors. For example, if an individual consumed 4 ounces of table wine (15% alcohol or 0.15) , every day, the QFI calculation would multiply $4 \times 0.15 \times 1 = 0.60$. Individual QFI scores were calculated for beer, wine, and liquor separately, and were used to derive a total QFI score (sum of all 3 QFI scores). The QFI is one of the most commonly used methods to determine quantity and frequency of alcohol use (e.g., Ceballos et al., 2012; King et al., 1997; Marlatt et al., 1998).

Family history of alcohol problems was quantitatively measured using a pedigree method developed by Mann et al. (1985). The quantitative score grouped participants as having either a positive or negative family history of alcohol problems. This method has been widely used to provide a sensitive index of familial alcoholism and problem drinking (e.g., Baer et al., 2003; Mitchell et al., 2005; Marlatt et al., 1998).

Procedure

Each experimental session lasted approximately 45 minutes. Upon arrival in the laboratory, the experimenter provided the participants with an overview of the study. They then read and sign an informed consent document. Participants then completed the 25-minute AB task on a computer. Afterwards, the participants filled out a questionnaire via Survey Monkey regarding basic demographics, alcohol consumption frequencies, and family history of problem drinking. Following the survey, the participants were debriefed.

IV. RESULTS

In total, 142 college students (105 females) were recruited from the Psychology department at Texas State University to participate in this study. Seventy-three participants performed the word-based version of the AB task, while sixty-nine participants performed the image-based task. Demographic characteristics of the sample are shown in Table 1.

Table 1. Characteristics of participants: Means (standard deviations in parentheses)^a

Variable	Experiment Type					
	Words			Images		
	Abstinent	Light	Heavy	Abstinent	Light	Heavy
Male, <i>n</i> (%)	3 (16.7)	5 (17.2)	6 (23.1)	13 (34.2)	4 (19)	6 (60)
Female, <i>n</i> (%)	15 (83.3)	24 (82.8)	20 (76.9)	25 (65.8)	17 (81)	4 (40)
Age ^a	22.3 (8.9)	22.2 (5.5)	21.3 (3.2)	19.2 (2.3)	19.8 (2.6)	21.0 (1.9)
QFI ^{a,b}	0	0.19 (.14)	1.43 (1.5)	0	0.16 (0.1)	2.93 (2.7)
FH ^{a,c}	1.58 (1.6)	1.81 (1.9)	1.14 (1.2)	1.01 (1.3)	0.86 (.86)	1.55 (1.9)
FH positive, <i>n</i> (%)	11 (61.1)	18 (62.1)	14 (53.8)	16 (42.1)	10 (47.6)	5 (50)
FH negative, <i>n</i> (%)	7 (38.9)	11 (37.9)	12 (46.2)	22 (57.9)	11 (52.4)	5 (50)

Notes: QFI = quantity-frequency index; FH = family history; ^bquantity-frequency index (Cahalan et al., 1969) = ounces of absolute ethanol per day during the previous 6-month period; ^cfamily history of alcohol problems (Mann et al., 1985)

In order to examine differences across demographic characteristics across consumption groups and experiments, Chi-Square tests and univariate ANOVAs were performed on demographic variables. A Chi-Square test of gender distributions across drinking groups was equal for both experiments ($\chi(4) = 7.37, p > .05$) and family history

of drinking problems across drinking groups was equal for both experiments ($\chi(2) = 0.650, p > .05$). An ANOVA was performed on total QFI scores, with experiment type as a fixed factor and drinking group as a random factor, revealing a significant drinking group x experiment type interaction, $F(2,136) = 7.19, p = .001$. More specifically, self-reported QFI for the heavier drinking group was lower for those in the word-based experiment than those in the image-based experiment.

In order to gain an overall picture of the behavioral data, an omnibus mixed ANOVA was performed on T2 identification accuracy with drinking group (abstinent, light, heavy), family history (positive or negative), and experiment type (words or images) as between-subjects factors, and lag (2,4, or 6) and T2 target type (alcohol or non-alcohol) as within-subjects factors. The ANOVA revealed a main effect for lag, $F(2,260) = 16.12, p = .000$, where overall T2 accuracy was 0.854 ($SE = .008$) at lag 2, 0.879 ($SE = .007$) at lag 4, and 0.875 ($SE = .008$) at lag 6 (see Figure 1). There was also a main effect for T2 target type, $F(1,130) = 29.26, p = .000$, where participants had a greater overall accuracy for alcohol T2 (0.898, $SE = .008$) than non-alcohol T2 (0.841, $SE = .010$), as well as a main effect for experiment type, $F(1,130) = 124.63, p = .000$, where overall T2 accuracy was greater for words (.949, $SE = .009$) versus images (.790, $SE = .011$). However, these main effects were mitigated by several interactions.

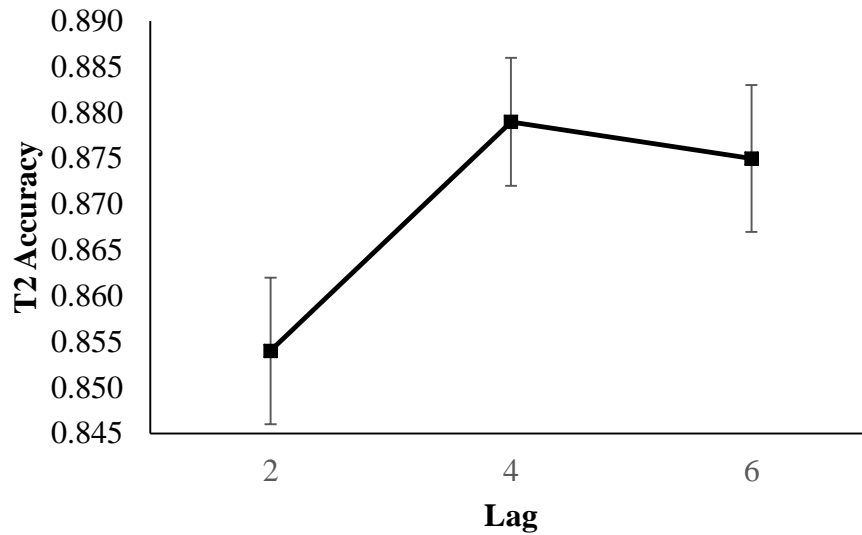


Figure 1. Main effect of lag on overall T2 accuracy. Significant at the $p < .05$ level.

Significant interactions were found between T2 target type and lag, $F(2,260) = 4.56, p = .013$ (see Figure 2), between T2 target type and experiment type, $F(1,130) = 20.94, p = .000$, and between experiment type and drinking group, $F(2,130) = 3.56, p = .031$. Other higher-order interactions were noted, including a T2 target type x lag x experiment type interaction, $F(2,260) = 4.56, p = .011$, and a lag x experiment type x family history interaction, $F(2,260) = 3.30, p = .039$. This latter interaction was likely the result of a performance decrease in family history positive individuals at lag 6 for the image-based experiment (Figure 3) but not the word-based experiment (Figure 4). Most importantly, the above effects were mitigated by a four-way interaction between T2 target type, lag, experiment type, and drinking group, $F(4,260) = 5.08, p = .001$.

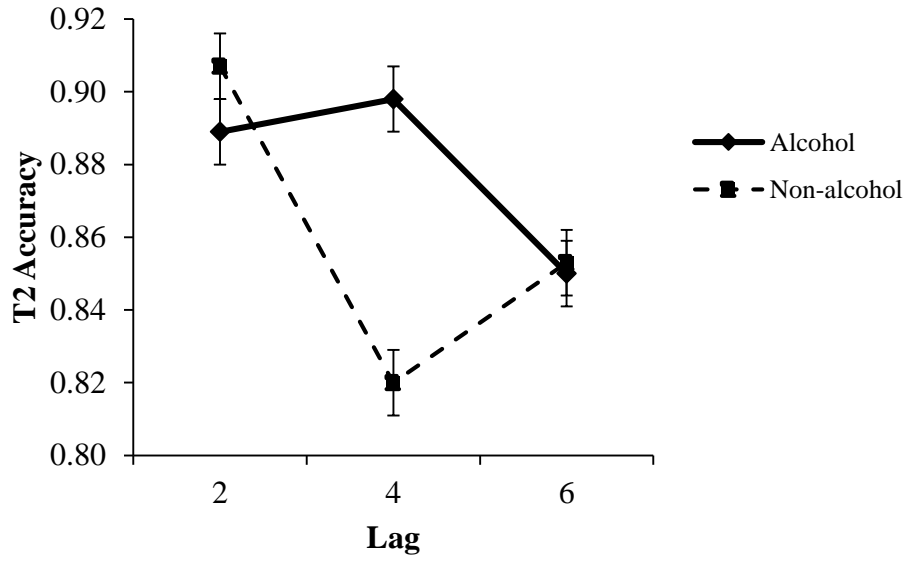


Figure 2. T2 target type x lag interaction. Significant at the $p < .05$ level.

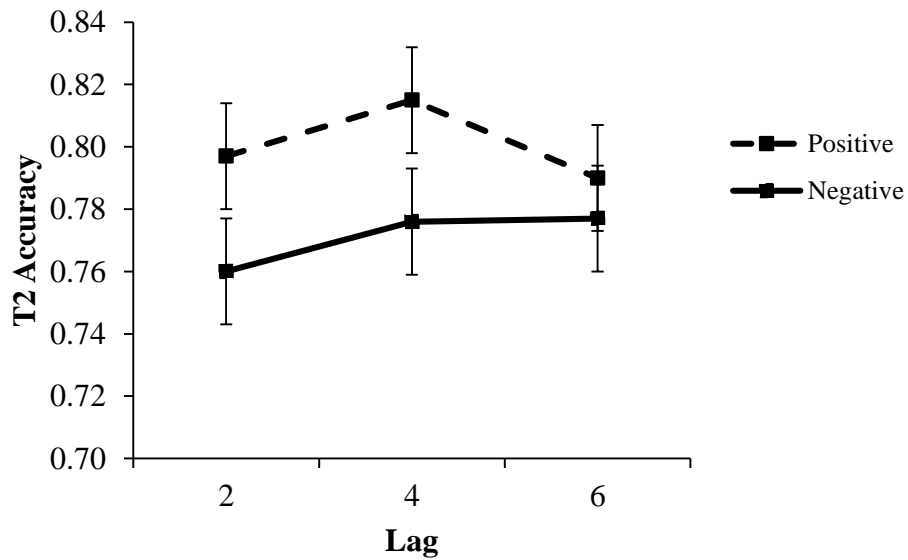


Figure 3. Image-based experiment: lag x family history interaction. Significant at the $p < .05$ level.

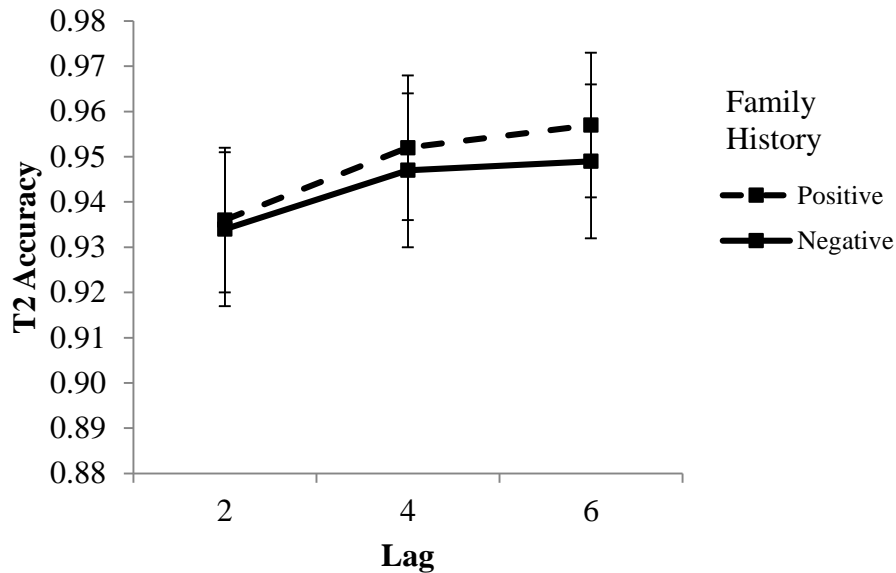


Figure 4. Word-based experiment: lag x family history interaction. Significant at the $p < .05$ level.

In order to interpret higher order interactions in the context of research hypotheses regarding the magnitude of the AB, an AB index of T2 accuracy was computed by subtracting performance at lag 2 from lag 4 for both alcohol and non-alcohol T2. As shown in Figure 1, T2 performance decreased at lag 6 relative to lag 4, suggesting that factors other than the AB (e.g., distraction) may have contributed to this decrement in performance. Therefore, an AB index (derived from subtracting accuracy at lag 2 from that at lag 4) was thought to be the best estimate of the AB, with positive AB index scores reflecting a larger AB (i.e., lower accuracy) at lag 2 relative to lag 4, while negative scores indicating a reversal of the AB (i.e., greater accuracy) at lag 2 relative to lag 4.

A follow-up ANOVA was performed on the accuracy of T2 identification with the AB index as the dependent variable, T2 target type (alcohol vs. non-alcohol) as a within-subjects factor and experiment type (words vs. images) and drinking group (abstinent, low, moderate) as between-subjects factors. This yielded a significant interaction between T2 target type, experiment, and drinking group, $F(2,130) = 5.46, p = .005$. In order to interpret this interaction, follow-up ANOVAs were performed for each experiment type using the same within- and between-subjects factors described above (excluding experiment type). The ANOVA of AB magnitude in the word-based version of the experiment yielded no significant main effects or interactions. However, the ANOVA of AB magnitude in the image-based version revealed a significant interaction between T2 target type and drinking group, $F(2,63) = 4.03, p < .05$. The null result of the word-based version is shown in Figure 5 and the interaction for the image-based version is shown in Figure 6.

As indicated by Figure 6, the largest differences in the AB to alcohol and non-alcohol images seemed to occur with the heavier drinking group, which is larger in the image-based version of the experiment. To confirm this, multiple paired-samples *t*-tests were performed to compare the AB index means between drinking groups in the image-based experiment. The *t*-test of differences in accuracy for alcohol vs. non-alcohol T2 was not significant for the abstinent drinking group, $t(37) = -0.156, p = .88$, as was that for the light drinking group, $t(20) = 1.54, p = 0.14$. However, this difference was significant for the heavier drinking group, $t(9) = -2.39, p = 0.04$, such that heavier drinkers had an attenuated AB (i.e., greater accuracy) for alcohol T2s versus non-alcohol T2s.

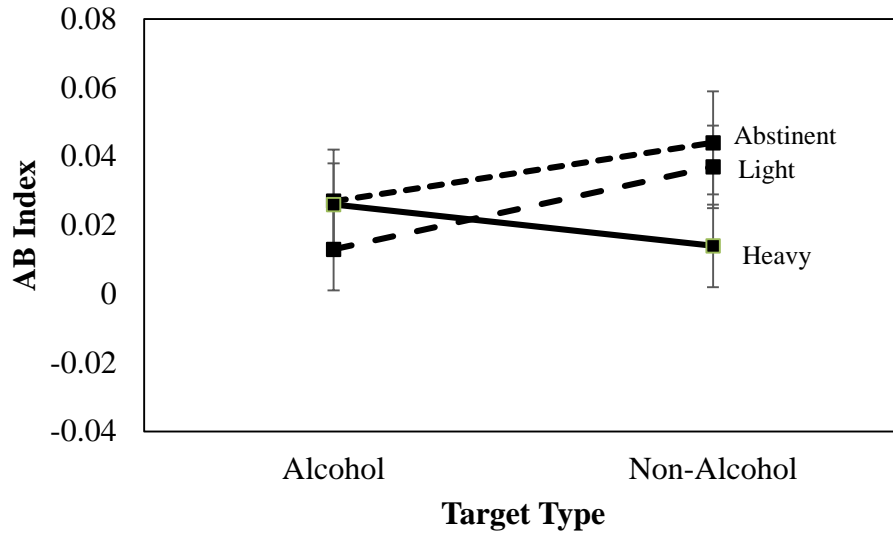


Figure 5. The interaction between T2 target type and drinking group for the word-based task version.

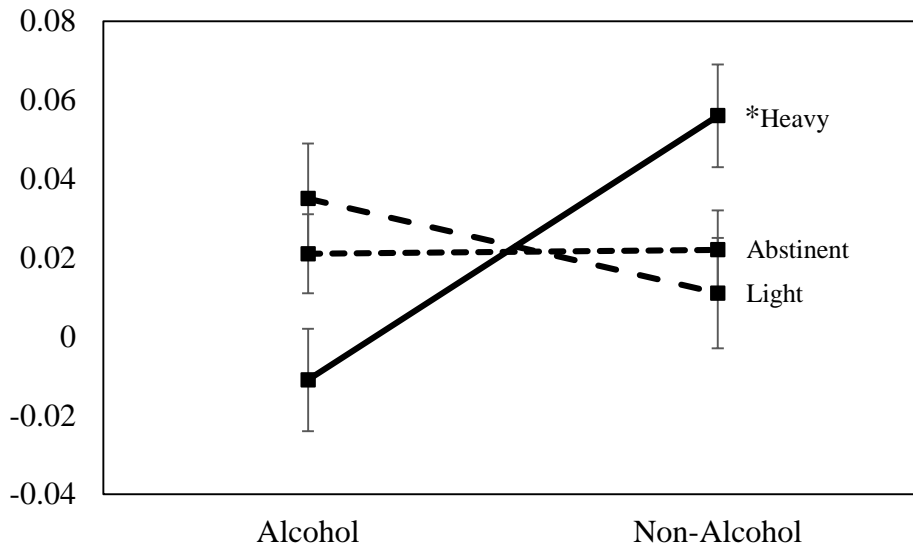


Figure 6. The interaction between T2 target type and drinking group for the image-based task version. *Significant at the $p < .05$ level.

V. DISCUSSION

Attentional biases for alcohol-related cues have been consistently demonstrated in individuals who drink heavily (Johnsen et al., 1994) or engage in potentially harmful drinking patterns (e.g., binge drinking; Cox et al., 2002). However, much of this research has failed to address the temporal dynamics of biases to alcohol- or drug-related cues, which could inform our understanding of how automatic attentional biases vary with drinking patterns that may be indicative of future problem drinking. Tibboel et al. (2010) used a word-based paradigm to study the AB in heavy drinkers and found an attenuated AB for alcohol-related words at early lags, suggesting more efficient processing of these cues. The present study extended this research by examining attentional biases in social drinkers using both a word- and image-based AB paradigm, in order to help clarify the time course of attention to alcohol-related cues. Results suggests that alcohol-related stimuli may be processed more efficiently at early levels of encoding in heavier social drinkers, particularly when viewing alcohol-related images. These results are discussed in further detail below in the context of experimental hypotheses and study aims.

The primary aim of this study was to examine whether alcohol-related stimuli are processed more efficiently at early levels of encoding than non-alcoholic stimuli, and if this was modulated by alcohol consumption patterns in social-drinking college students. Based on the results of Tibboel et al. (2010), it was predicted that the heavier social drinkers would have greater accuracy (e.g., attenuated AB) in identifying alcohol-related stimuli compared to light and abstinent drinkers (i.e., T2 target type x lag x drinking

group interaction). Additionally, it was thought that heavier drinkers would show a large AB effect for non-alcoholic stimuli, while the other drinking groups would possess an equally strong AB for both stimuli types. Together, this would suggest an attentional bias for alcohol-related cues exists in the heavier social drinkers, but not in the lighter or abstinent drinkers.

The results confirmed the presence of an AB, a decrement in performance between lags 2 and 4, evidenced by a main effect of lag. Accuracy for T2, regardless of its target status (alcohol or non-alcohol), was lowest at lag 2 (i.e., 220 ms from T1), indicative of an AB during this time frame. T2 accuracy increased from lag 2 to lag 4, but decreased from lag 4 to lag 6, which was unexpected. The increase in performance from lag 2 to 4 is consistent with previous research, in that the closer T2 is to T1, the less likely T2 will be accurately reported (i.e., stronger AB at shorter lags; Chun & Potter, 1995). Because the AB recovers after approximately 500 ms, T2 targets shown at a lag between 200 and 500 ms after T1 should show a strong AB, with performance recovering after 500 ms (e.g., lag 6). In the present study, performance declined at lag 6 relative to lag 4, suggesting that the AB window in the current study was shorter than Tibboel et al. (2010). This decrease in performance at longer lags and the observation of an AB prior to 440 ms may have been due to the fact that our sample consisted of young, healthy social drinkers and non-drinkers such that the AB recovered at shorter lags, and factors such as distraction exerted an influence on attention when longer lags intervened between T1 and T2 (i.e. between lags 4 and 6). Several studies have shown that individual differences can play a role in the observed AB effect. For example, older adults tend to exhibit a larger AB than younger adults (e.g., Lahar, Izaak, & McArthur, 2001; Maciokas & Crognale,

2003), while some individuals are able to consolidate information more quickly than others, yielding an attenuated or non-existent AB (Martens et al., 2006).

The omnibus ANOVA revealed a main effect of target type, such that participants had a greater overall accuracy for alcohol vs. non-alcohol T2s, regardless of lag. This finding makes sense, in that previous research has shown that T2 accuracy tends to be greater for motivationally relevant objects/stimuli (e.g., one's own name, Shapiro et al., 1997; emotionally significant words, Andersen, 2005). Given the sample of this study consisted of college students and that alcohol and alcohol-related cues are highly prevalent and often unavoidable in the college community, it seems likely that alcohol targets were more motivationally-relevant to most participants, regardless of individual consumption patterns. This result suggests that alcohol-related stimuli may be processed more efficiently at early levels of encoding, as evidenced by higher accuracy for alcohol T2 relative to non-alcohol T2, possibly due to their motivational relevance.

However, the main effects reported above were mitigated by several interactions, including a T2 target type x lag x experiment type x drinking group interaction. In order to interpret this interaction in the context of hypotheses of the AB, an index of AB magnitude was created and examined for each experiment separately. For the word-based version of the AB experiment, no significant interactions were noted. Drinking status (i.e., abstinent, light, heavy) had no significant effect on the magnitude of the AB, failing to support the primary hypothesis of this study. For the image-based version, a significant drinking status by target type interaction was noted. Further, a priori comparisons examining each drinking group separately showed no differences in the magnitude of the AB across target types (alcohol vs. non-alcohol) in abstinent and light drinkers. However,

heavier drinkers in this experiment showed a greater accuracy for alcohol T2 at lag 2 than for non-alcohol T2. This suggests that alcohol-related cues may be processed more efficiently than non-alcoholic cues in heavier drinkers, particularly at early levels of encoding (i.e., lag 2), but only when more salient targets (images) are used.

The reduction in AB magnitude for alcohol-related images in heavier drinkers in the second study is consistent with the Wiers et al. (2007) model of attentional bias, which suggests an incentive salience for substance-related stimuli arises from an appetitive-approach oriented system that becomes sensitized over time due to repeated cue exposure. In this case, alcohol becomes sensitized with repeated exposure and use, thus leading to an automatic tendency to seek it (also see Robinson & Berridge, 1993). This model proposes that automatic processes involved in addiction (i.e., implicit processes) recruit a fast, impulsive system that appraises stimuli automatically based on emotional/motivational significance outside of conscious control. These implicit measures provide a sensitive measurement in predicting future behavior (e.g., alcohol seeking). Thus, it is plausible that the reduction of the AB to alcohol images in heavier social drinkers was a consequence of these rapid attentional processes. This is consistent with studies reporting higher T2 identification rates for substance-related stimuli in cigarette smokers (Waters et al., 2007), opiate users (Liu et al., 2008), and most importantly, in heavy alcohol drinkers (Tibboel et al., 2010).

Nevertheless, the finding of this effect only for images and not for words requires further discussion. There are two explanations for these findings. First, the reduction of AB magnitude for alcohol-related images in the current study could imply that only alcohol-related images are processed more efficiently at early levels of encoding at least

by heavier social drinkers, in addition to an overall attentional bias for alcohol-related cues. Given the latency of these effects, these biases are likely to occur automatically; however, attentional biases in social drinkers may be subtler than those in heavy drinkers. It is possible that images of alcohol were more salient than words to heavier social drinkers, which resulted in the attenuation of the AB.

Alternatively, differences across studies could have been due to differences in alcohol consumption (QFI) across experiments, such that heavier social drinkers in the image-based study had significantly higher QFIs than those in the word-based version. Because the former group drank more heavily, it is possible that the observed biases were not due to the target type specifically. Rather, the reduction of the AB in that study could have been due to alcohol consumption differences across experiments. It is possible that the same reduction in the AB would have also been observed for alcohol-related had QFI scores across both heavier drinking groups been equivalent across studies. Thus, attentional biases at early levels of encoding may not be restricted to just pictorial stimuli, but may also exist for other alcohol-related cues (i.e., words). Future studies utilizing targeted recruitment techniques, in addition to time-sensitive techniques such as event-related potential (ERP) methodologies may help to resolve these questions.

Although the present study suggests that alcohol-related images may be processed automatically and more efficiently at early levels of encoding in heavier social drinkers, this is only speculative at this time. Tibboel et al. (2010) posits that heavier alcohol drinkers may require less attentional resources (i.e., more efficient processing) to become aware of alcohol-related information. Alternatively, Anderson (2005) suggests that although salient stimuli can be processed automatically, this does not necessarily result in

an enhanced or more efficient access to conscious awareness. Rather, arousal may be associated with reduced capacity limitations for conscious processing, yielding greater access to awareness for highly arousing stimuli (e.g., increased attentional capture). Thus, it is possible that through sensitization and repeated exposure, as well as the resulting automatic tendency to seek it, alcohol becomes highly arousing to the user. The arousing nature of alcohol-related images may help explain the preferential processing of these stimuli when competing with other stimuli (e.g., T1, distracters) in an RSVP stream, yielding a greater chance of accessing conscious awareness as evidenced by a reduced AB. Given the current behavioral data, it is difficult to conclude if alcohol-related cues are processed more efficiently, or whether another factor (e.g., increased attentional capture, preferential processing) is responsible for the observed AB effects. Future studies employing ERP methodologies may help to more closely examine this phenomenon and help determine the attentional status of alcohol-related cues at early levels of encoding.

A secondary aim of this study was to examine any individual differences that may modulate the AB effect, such as family history of alcohol-related problems. Those with a positive family history were expected to show an attenuated AB for alcohol-related stimuli (i.e., greater accuracy), independent of personal consumption. In short, the present results do not support the original prediction that participants with a positive family history would show an attenuated AB for alcohol-related stimuli. Although a family history x lag x experiment type interaction was reported, a differential performance decrement at lag 6 in the images experiment in family history positive participants was the likely cause of this interaction. Direct examination of the AB index (derived from

accuracy at lags 2 and 4) did not reveal any significant main effects or interactions involving family history. Therefore, it is reasonable to conclude that family history did not modulate the AB as expected.

There are several possible explanations for this finding, the majority of which may be related to how family history of alcohol problems were assessed. In the current study, it was assessed using a pedigree method developed by Mann et al. (1985), which relied on self-report. Although this method has been widely used as a sensitive index of familial alcohol problems, it is possible that the participants of this study failed to accurately report familial problem drinking. Because this pedigree method assigns anyone with a single first-generation relative with alcohol problems or two or more secondary relatives (e.g., grandparent) as family history positive, a subset of these individuals may not have had any first-generation relatives (e.g., parents) with alcohol problems. Some studies showing an attentional bias toward alcoholic cues in family history positive participants suggest that these biases are stronger in individuals who reported parent(s) as problem drinkers (Zetteler et al., 2006). Further, Dager et al. (2013) found greater cue-reactivity to alcoholic cues in participants with a positive family history, as defined as reporting at least one first degree relative with problem drinking. Therefore, it is possible that the inclusion of participants with 2, second-degree relatives into the family history positive group may have obscured group differences.

An alternative explanation is that although it is possible that family history positive individuals may have an inherent attentional bias toward alcoholic cues, these differences might not be manifested at early levels of encoding. Zetteler et al. (2006) assessed these biases in individuals with a positive family history of alcohol problems

using a supraliminal (i.e., with awareness) and subliminal (i.e., without awareness; stimuli briefly presented followed by a visual mask) alcohol Stroop task. The subliminal Stroop task allowed researchers to examine pre-attentive biases at early stages of encoding. Attentional biases for alcohol-related words were evident only in the supraliminal task, but not in the subliminal task, suggesting that these biases related to familial drinking problems are not likely to be manifested during early levels of encoding.

The final aim of this study was to compare the effectiveness of a word-based AB paradigm and an image-based paradigm, as previous AB studies differ in respect to the target stimuli being used. Words and images have been shown to share common neural substrates (e.g., Vandenberghe et al., 1996), and it was possible that a reduction in AB effect to alcohol-related images would be the same across word- and image-based studies. Conversely, because visual cues more closely represent stimuli encountered in everyday life, images of alcoholic beverages could capture attention more efficiently, resulting in an attenuation of the AB for alcohol relative to non-alcohol images. Furthermore, this effect may be most evident in heavier social drinkers compared to lighter drinkers and non-drinkers.

Overall, there was a significant difference in overall T2 identification between both experiment types, such that the word-based version yielded significantly higher identification rates (regardless of T2 type) than the image-based version. It is important to remember that for both task versions, participants were asked to categorize both T1 and T2 at the end of the RSVP stream, rather than explicitly report each target. It is possible that participants had greater difficulty in discriminating pictures versus words, resulting in an overall lower T2 identification rate for images. Images were matched based on

properties such as size, shape, and color, thus, it is likely that some ambiguity may have existed between category membership for target images but not for words. It is unlikely that priming or repetition can explain these differences, as research has shown that priming effects often occur with both words and images (e.g., Carroll & Kirsner, 1982; Grill-Spector, Henson, & Martin, 2006). Although difficulties in target discrimination for pictures versus words is the most plausible conclusion to explain overall lower T2 identification rates in the images experiment, future studies are needed to investigate these differences using ERPs.

As mentioned earlier, a drinking group x target type interaction was noted for heavier drinkers in the image-based experiment, but not for heavier drinkers in the word-based version. Further, heavier social drinkers had a reduced AB for alcohol versus non-alcohol images, but not for alcohol-related words. It is possible that the participants in this study encountered alcohol-related cues in the form of visual representation (e.g., a beer bottle) more often than lexical representations in the real world, thus a greater ecological validity for images and a more efficient capture of attention at early levels of encoding. Although Tibboel et al. (2010) found a reduced AB for alcohol-related words at early lags, their sample consisted of much heavier drinkers than the social college drinkers recruited for this experiment. It is possible that the drinking group x target type interaction would have manifested in the word-based task if that group had consisted of a heavier drinking sample. Taken together, the present results support the prediction that heavier social drinkers would show an attenuated AB for images of alcoholic beverages relative to non-alcoholic beverages, suggesting a more efficient capture of attention for alcohol-related images. Alternatively, this result may have been due to heavier alcohol

consumption in that particular group. Future studies examining electrophysiological indices of attention (i.e., ERPs), as well as targeted recruiting, could help to resolve this issue.

Overall, the results of this study revealed that heavier social drinkers exhibited an attenuated AB at early levels of encoding (i.e., lag 2) for alcohol-related images, but not for words. However, there are some limitations that may temper this conclusion. First, the sample recruited for participation was not screened prior to the lab visit for alcohol consumption patterns or family history of alcohol problems. Those categorized in the present study as heavier social drinkers required a total alcohol QFI of 0.5 or greater (e.g., 1-2 drinks per day). According to the NIAAA (2014), heavy drinkers are typically classified as having more than 5 drinks per day, while moderate drinkers consume between 1 and 2 drinks per day. The present grouping of participants as heavier social drinkers had a large range, some of whom would be classified as moderate drinkers (according to NIAAA, 2014) while others would have been correctly classified as heavy drinkers. In order to produce potentially more substantial AB effects in accurately represented drinking groups, future studies should pre-screen for QFI scores in order to group individuals based on NIAAA (2014) guidelines. Additionally, the heavier drinking group established in the images experiment had a small sample size ($n = 10$) while the word-based task had a larger sample of heavier drinkers ($n = 26$). Consequently, it is possible that the observed AB effects in the images experiment would change (e.g., diminish) with a larger sample of heavier drinkers. Also, it is expected that a clinical population of people with an AUD or problem drinking would also produce much more

substantial AB effects, as alcohol consumption is much more of an issue with this population than in college students who drink socially.

Although an overall AB was observed, suggesting the task was effective in detecting the desired effects, there are some limitations in the task design for both versions of the experiment. Much of the design, especially its timing, was based on the AB study by Tibboel and colleagues (2010), which originally produced significant AB effects in heavy alcohol drinkers (i.e., greater than 21 drinks per week). Although their design seemed to provide a reliable AB task, the present study had near-ceiling performance on the word task, suggesting that the task was too easy. Therefore, future studies using similar samples should consider changing some task parameters (e.g., ISI, stimulus presentation time, lag) potentially making the task more difficult, thus more likely to show more substantial AB effects that could further define the time course of attentional biases. Additionally, a potentially important drawback of the present study is that it relied on T1 and T2 categorization at the end of each RSVP stream, while in the Tibboel et al. (2010) study and other AB studies on substance abuse (e.g., Waters et al., 2007; Liu et al., 2008). Participants were required to either verbally report each target or type it in. Again, categorization of the targets instead of explicit report may have decreased task difficulty, ultimately failing to effectively measure stimulus processing at early, unconscious levels of encoding.

Furthermore, both tasks involved alcohol-related stimuli not particular to each participant's preferences. Although the target stimuli varied between alcohol type (e.g., beer, wine, liquor), it is possible that more substantial AB effects and attentional biases would be produced if the target stimuli were more personally relevant to the participants'

alcohol preference. Research has shown that beverage preference may play a role in determining an individual's alcohol use patterns (Del Rio, Prada, & Alvarez, 1995). Because people develop these beverage preferences through repeated alcohol use (e.g., Wiers et al., 2007), subsequent biases may not be generalizable to all alcohol-related stimuli. Therefore, attentional biases to alcohol-related cues may be more enhanced to preferred beverages, especially in younger drinkers. Moreover, the AB tasks used only six different stimuli for alcohol T2, presented multiple times throughout the experiment. In future studies, more variation in T2 stimuli would be ideal, as to help eliminate any priming or repetition effects.

In summary, college students tend to have an overall attentional bias for alcohol-related stimuli independent of their alcohol consumption frequencies and patterns. Other individual factors such as having a positive family history of alcohol problems did not modulate the AB effect, in that these individuals did not show an attentional bias for alcoholic cues at early levels of encoding, independent of their own drinking patterns. The word-based version of the AB task failed to produce any substantial AB effects or biases at early lags in heavier social drinkers. However, the image-based version did show an attenuated AB at lag 2 for alcohol-related images in heavy drinkers. It is possible that images more effectively captured attention due to their greater ecological validity and efficacy as appetitive stimuli. This would also suggest that a more efficient processing of alcohol-related stimuli at early levels of encoding may exist in heavier drinkers, particularly when presented with pictorial stimuli. This phenomenon likely occurs automatically and outside of conscious awareness, congruent with Wiers et al. (2007) appetitive-approach model, in that alcohol becomes sensitized with repeated

exposure and use, leading to drug-seeking behaviors (Robinson & Berridge, 1993). However, it is important to keep in mind that the heavier drinking group in the image-based task had higher QFI scores than those in the word-based task, which may have been responsible for the observed results. Therefore, it is possible that similar results would have been observed in the word-based task if QFI had been higher in this group.

The results of this study have implications for understanding the time course of attentional biases to alcohol-related cues, as well as how efficient these cues are processed outside of conscious awareness. Alcohol-related cues have been shown to capture attention in heavier drinkers (Tibboel et al., 2010), which is likely the result of repetitive alcohol use, but may also serve as a marker of future alcohol problems in social drinkers. Collectively, these findings may help assess an individual's risk for future problem drinking or the development of an AUD. However, in order to determine the effectiveness of the AB paradigm in assessing attentional bias and subsequent AUD risk, future studies are needed in clinically addicted populations (e.g., treatment-seeking individuals). Although the present results are promising, it is important to investigate these effects and the associated neural correlates by using event-related brain potentials. Investigating ERP correlates of attentional capture may help to provide a more sensitive interpretation of the time course of these biases and can be used to supplement, as well as clarify behavioral data. Ultimately, understanding attentional biases to alcoholic cues may help inform treatment options (e.g., attentional bias modification therapies) in individuals with an existing AUD, or help assess an individual's risk in developing an AUD, thus providing an opportunity for early intervention and subsequent prevention.

REFERENCES

- Allport, A. (1987). Selection-for-action: Some behavioral and neurophysiological considerations of attention and action. In H. Heuer & A.F. Sanders (Eds.), *Perspectives on Perception and Action*. Hillsdale, NJ: Erlbaum.
- Allport, A. (1990). Visual attention. In M. Posner (Ed.), *Foundation of Cognitive Science* (pp. 631- 682). Cambridge, MA: MIT Press.
- Anderson, A.K. (2005). Affective influences on the attentional dynamics supporting awareness. *Journal of Experimental Psychology: General*, *134*, 258-281.
- Awh, E., Serences, J., Laurey, P., Dhaliwal, H., van der Jagt, T., & Dassonville, P. (2004). Evidence against a central bottleneck during the attentional blink: Multiple channels for configural and featural processing. *Cognitive Psychology*, *48*(1), 95-126.
- Balkenius, C. (2000). Attention, habituation and conditioning: Toward a computational model. *Cognitive Science Quarterly*, *1*(2), 171-214.
- Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M.J., van Ijzendoorn, M.H. (2007). Threat-related attentional bias in anxious and non-anxious individuals: A meta-analytic study. *Psychological Bulletin*, *133*(1), 1-24.
- Baer, J. S., Sampson, P. D., Barr, H. M., Connor, P. D., & Streissguth, A. P. (2003). A 21-year longitudinal analysis of the effects of prenatal alcohol exposure on young adult drinking. *Archives of General Psychiatry*, *60*(4), 377-385.

- Bruce, G., & Jones, B.T. (2006). Methods, measures, and findings of attentional bias in substance use, abuse, and dependence. In R.W. Wiers & A.W. Stacy (Eds.), *Handbook of Implicit Cognition and Addiction* (pp. 135-149). Thousand Oaks, CA: Sage.
- Bradley, B.P., Mogg, K., Wright, T., & Field, M. (2003). Attentional bias in drug dependence: Vigilance for drug-related cues in smokers. *Psychology of Addictive Behaviors, 17*, 66-72.
- Bruce, G., & Jones, B. T. (2004). A pictorial Stroop paradigm reveals an alcohol attentional bias in heavier compared to lighter social drinkers. *Journal of Psychopharmacology, 18*(4), 527-533.
- Bruce, G., & Jones, B.T. (2006). Methods, measures, and findings of attentional bias in substance use, abuse, and dependence. In R.W. Wiers & A.W. Stacy (Eds.), *Handbook of Implicit Cognition and Addiction* (pp. 135-149). Thousand Oaks, CA: Sage.
- Campbell, W.G. (2003). Addiction: a disease of volition caused by a cognitive impairment. *Canadian Journal of Psychiatry, 48*, 669-674.
- Carroll, M., & Kirsner, K. (1982). Context and repetition effects in lexical decision and recognition memory. *Journal of Verbal Learning and Verbal Behavior, 21*(1), 55-69.
- Castiello, U. (1999). Mechanism of selection for the control of hand action. *Trends in Cognitive Science, 3*(7), 264-271.

- Ceballos, N. A., Giuliano, R. J., Wicha, N. Y., & Graham, R. (2012). Acute stress and event-related potential correlates of attention to alcohol images in social drinkers. *Journal of Studies on Alcohol and Drugs*, 73(5), 761-771.
- Chun, M. M., & Potter, M. C. (1995). A two-stage model for multiple target detection in rapid serial visual presentation. *Journal of Experimental Psychology: Human Perception and Performance*, 21(1), 109.
- Cisler, J. M., Bacon, A. K., & Williams, N. L. (2009). Phenomenological characteristics of attentional biases towards threat: A critical review. *Cognitive Therapy and Research*, 33(2), 221-234.
- Cloninger, C. R. (1987). Neurogenetic adaptive mechanisms in alcoholism. *Science*, 236(4800), 410-416.
- Cox, W. M., Hogan, L. M., Kristian, M. R., & Race, J. H. (2002). Alcohol attentional bias as a predictor of alcohol abusers' treatment outcome. *Drug and alcohol dependence*, 68(3), 237-243.
- Cranford, J. A., McCabe, S. E., & Boyd, C. J. (2006). A new measure of binge drinking: prevalence and correlates in a probability sample of undergraduates. *Alcoholism: Clinical and Experimental Research*, 30(11), 1896-1905.
- Dager, A. D., Anderson, B. M., Stevens, M. C., Pulido, C., Rosen, R., Jiantonio-Kelly, R. E., ... & Pearlson, G. D. (2013). Influence of alcohol use and family history of alcoholism on neural response to alcohol cues in college drinkers. *Alcoholism: Clinical and Experimental Research*, 37(1), 161-171.

- Del Rio, C., Prada, C., & Alvarez, F. (1995). Beverage effects on patterns of alcohol consumption. *Alcoholism: Clinical and Experimental Research*, 19(6), 1583-1586.
- DeSchepper, B., & Treisman, A. (1996). Visual memory for novel shapes: Implicit coding without attention. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 22(1), 27.
- Ehrman, R.N., Robbins, S.J., Bromwell, M.A., Lankford, M.E., Monterosso, J.R., & O'Brien, C.P. (2002). Comparing attentional bias to smoking cues in current smokers, former smokers, and non-smokers using a dot-probe task. *Drug and Alcohol Dependence*, 67, 185-191.
- Field, M., Mogg, K., Zetteler, J., & Bradley, B.P. (2004). Attentional biases for alcohol cues in heavy and light social drinkers: the roles of initial orienting and maintained attention. *Addiction*, 176, 88-93.
- Field, M., Christansen, P., Cole, J., & Goudie, A. (2007). Delay discounting and the alcohol Stroop in heavy drinking adolescents. *Addiction*, 102, 579-586.
- Field, M., & Cox, W.M. (2008). Attentional bias in addictive behaviors: A review of its development, causes, and consequences. *Drug and Alcohol Dependency*, 97, 1-20.
- Fox, E., Russo, R., & Georgiou, G. (2005). Anxiety modulates the degree of attentive resources required to process emotional faces. *Cognitive, Affective & Behavioral Neuroscience*, 5, 393-404.
- Franken, I. H. (2003). Drug craving and addiction: integrating psychological and neuropsychopharmacological approaches. *Progress in Neuropsychopharmacology and Biological Psychiatry*, 27(4), 563-579.

- Fromme, K., Stroot, E. & Kaplan, D. (1993). Comprehensive effects of alcohol: development and psychometric assessment of a new expectancy questionnaire. *Psychological Assessment, 5*(1), 19-26.
- Grant, B. F., & Dawson, D. A. (1997). Age at onset of alcohol use and its association with DSM-IV alcohol abuse and dependence: results from the National Longitudinal Alcohol Epidemiologic Survey. *Journal of Substance Abuse, 9*, 103-110.
- Grill-Spector, K., Henson, R., & Martin, A. (2006). Repetition and the brain: Neural models of stimulus-specific effects. *Trends in Cognitive Sciences, 10*(1), 14-23.
- Goodman, A. (1990). Addiction: definition and implications. *British Journal of Addiction, 85*, 1403-1408.
- Goodman, A. (2009). The neurobiological development of addiction: An overview. *Psychiatric Times, 26*, 1-14.
- Haertzen, C.A., Kocher, T.R., & Miyasato, K. (1983). Reinforcements from the first drug experience can predict later drug habits and/or addiction: results with coffee, cigarettes, alcohol, barbiturates, minor and major tranquilizers, stimulants, marijuana, hallucinogens, heroin, opiates and cocaine. *Drug and Alcohol Dependence, 11*, 147-165.
- Hatterer, L.J. (1982). The addictive process. *Psychiatric Quarterly, 54*, 149-156.
- Haylett, S.A., Stephenson, G.M., & Lefever, R.M.H. (2004). Covariation in addictive behaviors: a study of addictive orientations using the shorter PROMIS questionnaire. *Addictive Behavior, 29*, 61-71.

- Hester, R., Dixon, V., & Garavan, H. (2006). A consistent attentional bias for drug-related material in active cocaine users across word and picture versions of the emotional Stroop task. *Drug and Alcohol Dependence, 81*, 251-257.
- Isaak, M.I., Shapiro, K.L., & Martin, J. (1999). The attentional blink reflects retrieval competition among multiple rapid serial visual presentation items: Tests of an interference model. *Journal of Experimental Psychology: Human Perception and Performance, 25*, 1774-1792.
- Jackson, M.C. & Raymond, J.E. (2006). The role of attention and familiarity in face identification. *Perception and Psychophysics, 68*, 543-557.
- Johnsen, B.H., Laberg, J.C., Cox, W.M., Vaksdal, A., & Hugdahl, K. (1994). Alcohol subjects' attentional bias in the processing of alcohol-related words. *Psychology of Addictive Behaviors, 8*, 111-115.
- Jones, B.C., Jones, B.T., Blundell, L., & Bruce, G. (2002). Social users of alcohol and cannabis who detect substance-related changes in a change blindness paradigm report higher levels of use than those detecting substance-neutral changes. *Psychopharmacology, 165*, 93-96.
- King, A. C., Volpicelli, J. R., Frazer, A., & O'Brien, C. P. (1997). Effect of naltrexone on subjective alcohol response in subjects at high and low risk for future alcohol dependence. *Psychopharmacology, 129*(1), 15-22.
- Lahar, C. J., Isaak, M. I., & McArthur, A. D. (2001). Age differences in the magnitude of the attentional blink. *Aging, Neuropsychology, and Cognition, 8*(2), 149-159.
- LeDoux, J.E. (1996). *The emotional brain*. New York: Simon & Schuster.

- Lee, L. O., & Knight, B. G. (2009). Attentional bias for threat in older adults: moderation of the positivity bias by trait anxiety and stimulus modality. *Psychology and Aging, 24*(3), 741-747.
- Le Pelley, M. E., Mitchell, C. J., & Johnson, A. M. (2013). Outcome value influences attentional biases in human associative learning: dissociable effects of training and instruction. *Journal of Experimental Psychology: Animal Behavior Processes, 39*(1), 39-55.
- Liu, N., Li, B., Sun, N., & Ma, Y. (2008). Effects of addiction-associated and affective Stimuli on the attentional blink in a sample of abstinent opiate dependent patients. *Journal of Psychopharmacology, 22*, 1091-1102.
- Love, A., James, D., & Willner, P. (1998). A comparison of two alcohol craving questionnaires. *Addiction, 93*(7), 1091-1102.
- Maciokas, J. B., & Crognale, M. A. (2003). Cognitive and attentional changes with age: Evidence from attentional blink deficits. *Experimental Aging Research, 29*(2), 137-153.
- MacLaren, V.V., & Best, L.A. (2010). Multiple addictive behaviors in young adults: Student norms for the shorter PROMIS questionnaire. *Addictive Behavior, 35*, 252-255.
- MacLeod, C., Matthews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *Journal of Abnormal Psychology, 95*(1), 15-20.
- Mann, R. E., Sobell, L. C., Sobell, M. B., & Pavan, D. (1985) Reliability of a family tree questionnaire for assessing family history of alcohol problems. *Drug and Alcohol Dependence, 15*(1-2), 61-67.

- Maratos, F.A., Mogg, K., & Bradley, B.P. (2008). Identification of angry faces in the attentional blink. *Cognition and Emotion*, 22(7), 1340-1352.
- Marlatt, G. A., Baer, J. S., Kivlahan, D. R., Dimeff, L. A., Larimer, M. E., Quigley, L. A., ... & Williams, E. (1998). Screening and brief intervention for high-risk college student drinkers: results from a 2-year follow-up assessment. *Journal of Consulting and Clinical Psychology*, 66(4), 604.
- Martens, S., Munneke, J., Smid, H., & Johnson, A. (2006). Quick minds don't blink: Electrophysiological correlates of individual differences in attentional selection. *Journal of Cognitive Neuroscience*, 18(9), 1423-1438.
- Milders, M., Sahraie, A., Logan, S. & Donnellon, N. (2006). Awareness of faces is modulated by their emotional meaning. *Emotion*, 6, 10-17.
- Millstein, S.G., & Iwin, C.E. (1988). Accident related behaviors in adolescence: A biopsychosocial view. *Alcohol, Drugs, and Driving*, 4, 21-29.
- Mitchell, J. M., Fields, H. L., D'Esposito, M., & Boettiger, C. A. (2005). Impulsive responding in alcoholics. *Alcoholism: Clinical and Experimental Research*, 29(12), 2158-2169.
- National Institute on Alcohol Abuse and Alcoholism [NIAAA]. (2008). Genetics of alcohol use disorder. Retrieved from <http://www.niaaa.nih.gov/alcohol-health/overview-alcohol-consumption/alcohol-use-disorders/genetics-alcohol-use-disorders>.
- National Institute on Alcohol Abuse and Alcoholism [NIAAA]. (2014). Drinking levels defined. Retrieved from <http://www.niaaa.nih.gov/alcohol-health/overview-alcohol-consumption/moderate-binge-drinking>.
- Nordenfelt, L. (2010). On concepts and theories of addiction. *Philosophy, Psychiatry & Psychology*, 17, 27-30.

- Ohman, A. (1993). Fear and anxiety as emotional phenomena: Clinical phenomenology, evolutionary perspectives, and information processing systems. In M. Lewis & J.M. Haviland (Eds.), *Handbook of Emotions* (pp. 511-536). New York, NY: Guilford Press.
- Ohman, A. (1996). Preferential preattentive processing of threat in anxiety: Preparedness and attentional biases. In R.M. Rapee (Ed.), *Current Controversies in the Anxiety Disorders*. New York: Guildford Press.
- Orford, J. (2001). Addiction as excessive appetite. *Addiction*, *96*, 15-31.
- Potenza, M.N. (2010). What integrated interdisciplinary and translational research may tell us about addiction. *Addiction*, *105*, 790-796.
- Raymond, J. E., Shapiro, K. L., & Arnell, K. M. (1992). Temporary suppression of visual processing in an RSVP task: An attentional blink?. *Journal of Experimental Psychology: Human Perception and Performance*, *18*(3), 849.
- Robinson, B.E., & Berridge, K.C. (1993). The neural basis of drug craving: an incentive-sensitization theory of addiction. *Brain Research Reviews*, *18*, 247-291.
- Schmukle, S.C. (2005). Unreliability of the dot probe task. *European Journal of Personality*, *19*, 595-605.
- Schuckit, M.A., & Russel, J.W. (1983). Clinical importance of age at first drink in a group of young men. *American Journal of Psychiatry*, *142*, 1221-1223.
- Shapiro, K.L., Raymond, J.E., & Arnell, K.M. (1994). Attention to visual pattern information produces the attentional blink in rapid serial visual presentation. *Journal of Experimental Psychology: Human Perception and Performance*, *20*, 357-371.

- Shapiro, K.L., Caldwell, J. & Sorensen, R.E. (1997). Personal names and the attentional blink. *Journal of Experimental Psychology: Human Perception and Performance*, 23, 1061-1073.
- Stetter, F., Ackermann, K., Bizer, A., Straube, E. R., & Mann, K. (1995). Effects of disease- related cues in alcoholic inpatients: Results of a controlled “alcohol Stroop” study. *Alcoholism: Clinical and Experimental Research*, 19(3), 593-599.
- Stroop, J.R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, 18(6), 643-662.
- Sussman, S. & Sussman, A.N. (2011). Considering the definition of addiction. *International Journal of Environmental Research and Public Health*, 8, 4025-4038.
- Sy, J.L., & Giesbrecht, B. (2009). Target-target similarity and the attentional blink: Task relevance matters!. *Visual Cognition*, 17(3), 307-317.
- Tibboel, H., De Houwer, J., & Field, M. (2010). Reduced attentional blink for alcohol-related stimuli in heavy social drinkers. *Journal of Psychopharmacology*, 24(9), 1349-1356.
- Tipper, S.P., Howard, L.A., & Houghton, G. (1998). Action-based mechanism of attention. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, 353, 1385-1393.
- Townshend, J.M., & Duka, T. (2001). Attentional bias associated with alcohol cues: Differences between heavy and occasional social drinkers. *Psychopharmacology*, 157, 67-74.

- Trippe, R. H., Hewig, J., Heydel, C., Hecht, H., & Miltner, W. H. (2007). Attentional blink to emotional and threatening pictures in spider phobics: Electrophysiology and behavior. *Brain Research, 1148*, 149-160.
- Vandenberghe, R., Price, C., Wise, R., Josephs, O., & Frackowiak, R. S. (1996). Functional anatomy of a common semantic system for words and pictures. *Nature, 383*(6597), 254-256.
- Ward, J. (2010). *The student's guide to cognitive neuroscience* (2nd ed.). New York, NY: Psychology Press.
- Waters, H., & Green, M.W. (2003). A demonstration of attentional bias, using a novel Dual task paradigm, towards clinically salient material in recovering alcohol abuse patients. *Psychological Medicine, 33*, 491-498.
- Waters, A.J., Heishman, S.J., Lerman, C., & Pickworth, W. (2007). Enhanced identification of smoking-related words during the attentional blink in smokers. *Addictive Behaviors, 32*, 3077-3082.
- Watts, F.N., McKenna, F.P., Sharrock, R., & Trezise, L. (1986). Color naming of phobia-related words. *British Journal of Psychology, 77*(1), 97-108.
- Wiers, R. W., Bartholow, B. D., van den Wildenberg, E., Thush, C., Engels, R. C., Sher, K. J., ... & Stacy, A. W. (2007). Automatic and controlled processes and the development of addictive behaviors in adolescents: a review and a model. *Pharmacology Biochemistry and Behavior, 86*(2), 263-283.
- World Health Organization. (2014). *Global status report on alcohol and health*. Retrieved April 11th, 2015, from http://apps.who.int/iris/bitstream/10665/112736/1/9789240692763_eng.pdf.

Zetteler, J. I., Stollery, B. T., Weinstein, A. M., & Lingford-Hughes, A. R. (2006).

Attentional bias for alcohol-related information in adolescents with alcohol-dependent parents. *Alcohol and Alcoholism*, 41(4), 426-430.