MODERATION OF NEURAL ALCOHOL-CUE CRAVING BY CORE PERSONALITY SYSTEMS

by

NICOLE C. MECHIN

PHILIP GABLE, COMMITTEE CHAIR
WILL HART
STUART USDAN

A THESIS

Submitted in partial fulfillment of the requirements
for the degree of Master of Arts
in the Department of Psychology
in the Graduate School of
The University of Alabama

TUSCALOOSA, ALABAMA

2015

ABSTRACT

Alcohol cues are prevalent in our everyday lives (on commercials and billboards, in grocery ads, etc.). Past work has demonstrated that exposure to alcohol cues evokes alcohol craving as evidenced by cortical activation. Neural activity underlying cue-elicited craving is connected to core personality systems of approach motivation, avoidance motivation, and supervisory control. However, it is unclear which personality system is driving measures of frontal activation related to cue-elicited alcohol craving. The current study sought to determine which personality system moderates frontal asymmetric activation evoked by cue-elicited alcohol craving, when participants were exposed to alcohol or neutral pictures. Results revealed that greater trait impulsivity moderated the relationship between greater left-frontal activation and picture type. Approach motivation and avoidance motivation were unrelated to left-frontal activation and picture type. These results suggest that decreased activation of the supervisory control system (increased trait impulsivity) is responsible for greater left-frontal activation in response to cue-elicited alcohol craving, not increased activation of the approach system or the avoidance system.

LIST OF ABBREVIATIONS AND SYMBOLS

α	Cronbach's Alpha: Value of internal consistency
b	Beta: A standardized partial regression coefficient
F	F statistic: Value calculated by the ratio of two sample variances
Hz	Hertz: Unit of frequency
M	Mean: The sum of a set of values divided by the number of values in the set
Ms	Milliseconds
N	Samples size of a group
η_p^2	Partial Eta-Squared: Value of effect size
p	Probability associated with the occurrence under the null hypothesis of a value as extreme as or more extreme than the observed value
r	Pearson product-moment correlation coefficient
R^2	Coefficient of determination: Fit of the regression line to the data
s	Seconds
SD	Standard Deviation: Value of variation from the mean
t	T statistic: Value determining whether sample means differ
Ω	Ohms: Unit of electrical resistance
$<$	Less than
$>$	Greater than
$=$	Equal to

ACKNOWLEDGMENTS

My family has played such a major role in my life's progression. Behind every one of my accomplishments is my family providing encouragement, support, and most importantly love. Although each of my family members has played a vital role, I need to thank my mom most of all. I can't thank her enough for providing me with such a strong, inspiring, and caring role model. A special thank you also goes to my fiancé. He has sacrificed so much to help me reach my goals and achieve my dreams, and for that I am eternally grateful.

Thank you to my advisor and mentor Philip Gable for his assistance with this project. His guidance and advice was invaluable in completing this project. I would also like to thank my committee members Will Hart and Stuart Usdan for providing support and feedback at every junction of the thesis process. Finally, I would like to thank all of the members of the SCEN Lab (graduate and undergraduate alike) for their assistance in data collection. Without their help this project would not have been possible.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

Alcohol cues are a constant part of our environment: advertisements on billboards, T.V. commercials, and magazines; neon signs of alcohol brands on restaurants, and alcohol for purchase at bars, gas stations, and grocery stores. It is difficult not to encounter alcohol cues on a daily basis. Research has consistently demonstrated that the presentation of alcohol cues elicits cravings for alcoholic beverages. A meta-analysis of over 40 studies investigating cue reactivity found that alcohol cravings were higher following alcohol cues but not following neutral cues (Carter and Tiffany 1999). Importantly, this increase in craving is strong not only for addicted and heavy drinkers, but also for non-addicted individuals and light drinkers (Papachristou et al. 2012). Individuals may crave alcohol for reasons beyond the pharmacological effects. Alcohol is associated with social benefits, personal enhancement, sexual amelioration, and stress reduction (Fromme et al. 1993; Kuntsche et al. 2005).

Research has also shown that exposure to alcohol cues elicits behaviors associated with alcohol consumption (e.g., tension reduction, increased aggression) devoid of the pharmacological effects of consumption (Friedman et al. 2007). While it is clear that alcohol cues bear on physiological and behavioral processes associated with consumption, research has yet to clearly identify what aspects of personality moderate this relationship.

Underlying human behavior are three fundamental personality systems: the approach motivation system, the avoidance motivation system, and the supervisory control system. The approach motivation system, measured using the behavioral activation system scale (BAS), is theorized as the ‘go’ system responsible for behavioral approach actions as well as goal-directed behaviors (Depue and Collins 1999; Carver and Scheier 2008; Elliot 2008; Gray 1970; Gray 1987; Gray and McNaughton 2000). An enhanced approach system may drive cue-elicited alcohol craving in that individuals high in approach are more sensitive to rewards and more motivated by alcohol cues (Hicks et al. 2012; Zisserson and Palfai 2007). In contrast, the avoidance motivation system, measured using the behavioral inhibition system scale (BIS), is theorized as the ‘withdraw’ system responsible for avoidance behaviors that occur in response to threat and non-rewarding situations (Gray 1970; Gray 1987; Carver and Scheier 2008; Elliot 2008). Enhanced avoidance motivation observed in individuals with depression and anxiety has been linked with increased alcohol craving and consumption (Grant and Harford 1995; Cooney et al. 1997; Gordon et al. 2006).

The supervisory control system mediates the actions of the approach and avoidance systems (Kochanska and Knaack 2003; Rothbart and Rueda 2005; Nigg 2006; Carver and Connor-Smith 2010). This system exists as a regulatory system and functions by employing executive control to restrict impulses produced by the approach and avoidance systems. The supervisory control system is also needed to direct the priorities of the approach and avoidance systems. For example, without the supervisory control system, resources would be wasted in the excessive pursuit of desirable objects or the over avoidance of negative stimuli. Furthermore, biological models of human behavior identify approach, avoidance, and supervisory control as distinct personality systems. In addition, the supervisory control system may aid in allowing individuals to persevere through unpleasant or tedious tasks.

The supervisory control system is associated with inhibitory control, constraint, and effortful control. This system has an inverse relationship with trait impulsivity (Logan et al.

1997; Kochanska and Knaack 2003; Rothbart and Reuda 2005; Nigg 2006; Enticott et al. 2006; Carver and Connor-Smith 2010). Failure of the supervisory control system evidenced by elevated trait impulsivity reduces forethought and may leave individuals more vulnerable to desired impulses. Individuals higher in trait impulsivity may experience more inhibitory failure in the presence of alcohol cues resulting in greater cravings for alcoholic substances and subsequent consumption (Perry and Carroll 2008; Joos et al. 2013). Based on these three fundamental personality systems (approach, avoidance, and supervisory control), it seems likely that cue-elicited alcohol craving could stem from one of the following: increased activation of the approach system, increased activation of the avoidance system, or a reduced functioning of the supervisory control system.

Core Personality and Alcohol-Cue Craving

Past research suggests a relationship between cue-elicited alcohol craving and approach motivation. Individuals who believe alcohol enhances perceptions of attractiveness have an increased incentive or greater approach motivation toward the consumption of alcohol (Friedman et al. 2005). Alcohol is associated with positive mood states and high energy situations generally associated with approach motivation (Cyders and Smith 2008). The association between positive situations and alcohol can enhance approach motivation toward alcohol resulting in elevated cravings (Cox 1988). College students associate times of celebration with the consumption of alcohol (Del Boca et al. 2004), suggesting that approach-motivated situations and alcohol are strongly associated. Finally, research has also shown that individual differences in reward seeking tendencies, associated with approach motivation, are related to increased cravings for alcohol (Verheul et al. 1999). This past work suggests that alcohol craving may be associated with enhanced activation of the approach system.

Other research has suggested a relationship between an overactive behavioral avoidance system and cue-elicited alcohol craving. Individuals with an overactive avoidance system have a higher prevalence for increased cravings for alcohol and increased consumption of alcohol (Carpenter and Hasin 1998; Kushner et al. 2001; Gordon et al. 2006; Canan and Ataoglu 2008; Witkiewitz and Bowen 2010). Higher depressive symptomatology associated with greater avoidance motivation increases risk of substance craving and abuse (Gordon et al. 2006; Witkiewitz and Bowen 2010). Individuals high in avoidance are more sensitive to threats in the environment and more likely to experience negative affect. Drinking to reduce negative affect has been identified as a core motivational factor for consumption (Cooper et al. 1992). Highly anxious individuals report using alcohol as a way to reduce aversive states (Kushner et al. 2001; Canan and Ataoglu 2008). Individuals who drink to reduce negative affect are more likely to develop alcohol dependence (Carpenter and Hasin 1998). In sum, cue-elicited alcohol craving may be due to an over active avoidance system.

Alternatively, alcohol craving may also be associated with reduced functioning of the supervisory control system. Reduced functioning of the supervisory control system as measured by increased impulsivity enhances cravings for alcohol. Trait impulsivity is a better predictor of alcohol cravings than drinking styles (social versus compulsive drinking habits) (Papachristou et al. 2012). Additionally, individuals high in disinhibition tend to experience increased cravings for alcohol in the presence of alcohol cues (Verheul et al. 1999). Enhancing the supervisory control system has also been found to reduce alcohol craving (Field and Cox 2008; Garland et al. 2010; Leeman et al. 2014). For example, employing cognitive effort, such as redirecting attention away from alcohol cues can reduce the intensity of cue-elicited alcohol cravings (Field and Cox 2008). Strengthening the supervisory control system through mindfulness training reduces craving towards alcohol stimuli (Garland et al. 2010). This past work suggests that an under active supervisory control system may drive cue-elicited alcohol craving.

Based on past evidence examining the approach, avoidance, and supervisory control systems, cue-elicited alcohol craving is likely to be associated with one of these systems. The current study seeks to understand which of these systems governs cue-elicited alcohol cravings. Specifically, the current study seeks to understand the influence of these personality systems by examining the influence of these three systems on neural measures of cue-elicited alcohol craving.

Frontal Asymmetry and Alcohol Craving

Much research has identified activation of the frontal cortex as a neural correlate of alcohol craving (George et al. 2001; Tapert et al. 2003; Tapert et al. 2004; Wrase et al. 2002). Greater frontal cortical activation is associated with alcohol consumption (Goldstein and Volkow 2002), desire for alcoholic substances, and alcoholism (George et al. 2001). Temporarily lesioning the dorsolateral prefrontal cortex using transcranial direct current stimulation (tDCS) administration effectively diminishes alcohol cravings (Boggio et al. 2007). Additionally, functional magnetic resonance imaging (fMRI) research has identified activity in the orbitofrontal cortex as a neural correlate of cue-elicited craving (George et al. 2001; Tapert et al. 2003; Wrase et al. 2002).

Importantly, the frontal cortex demonstrates asymmetrical functioning of the right and left hemispheres. Craving has been associated with greater left-frontal activation across several different domains, such as cocaine cravings (van de Laar et al. 2004), nicotine cravings (McClernon et al. 2005), and internet use cravings (Han et al. 2011). This body of work has provided evidence that the subjective feeling of craving is associated with greater activity in the left frontal cortex. Other work has found that the current urge to consume alcohol in response to alcohol cues activates the left orbitofrontal cortex (Myrick et al. 2004[1]).

Frontal activation has been asymmetrically related to the fundamental personality systems of approach and avoidance (Broca, 1861; Sperry et al. 1969; Gazzaniga 1985; Toga and Thompson 2003). Greater relative activation of the right frontal cortex is associated with the avoidance system (Sutton and Davidson 1997; Aron et al. 2004; Elliot 2008). In contrast, greater relative activation of the left frontal cortex is associated with the approach system (Sutton and Davidson 1997; Coan and Allen 2003; Harmon-Jones et al. 2010; Goldstein 1939; Rossi and Rosadini 1967; Harmon-Jones 2003; Harmon-Jones and Gable 2009).

Previous research has shown that both trait and state levels of approach motivation have been associated with greater left than right frontal cortical activity. Precisely, approach motivation states elicited using dessert pictures (Harmon-Jones 2003; Harmon-Jones and Gable 2009) and trait approach motivation, measured using the BAS scale (Carver and White 1994; Harmon-Jones and Sigelman 2001; Coan and Allen 2003; Amodio et al. 2008) have been associated with greater left frontal activity. Similarly, previous research has shown that avoidance motivation has been associated with greater right than left frontal cortical activity. State behavioral avoidance measured using the BIS scale (Carver and White 1994) is related to resting or baseline right frontal activation (Sutton and Davidson 1997; Aron et al. 2004; Elliot 2008). Additionally, experimental paradigms manipulating avoidance motivation through

[1] Despite much research linking craving with greater left frontal activation, some may argue that craving might be associated with right frontal activation. Individuals with overactive avoidance systems display greater right frontal activation (Davidson 1992; Sutton and Davidson 1997) and greater alcohol craving (Gordon et al. 2006; Witkiewitz and Bowen 2010), however, the connection between right front activity and alcohol cue craving seems tenuous. Evidence suggests that cue-evoked alcohol craving is related to greater left-frontal asymmetry.

disgusting images (Davidson et al. 1990) and punishment cues (Sobotka et al. 1992) evoke greater relative right frontal activation.

Despite the approach and avoidance systems being strongly associated with greater left or right frontal activation, only recently has past work linked the supervisory control system with frontal asymmetry (Aron et al. 2014; Grimshaw and Carmel 2014). Trait sensation seeking has been linked to greater right frontal alpha activity at baseline (Santesso et al. 2008). Greater behavioral risk taking has been linked to right frontal theta and delta activation (Gianotti et al. 2009). Additionally, Gable, Mechin, Hicks, and Adams (in press) had participants respond to a measure of trait impulsivity (positive urgency) and measured baseline (e.g., trait) frontal asymmetry. The results found that trait impulsivity related to greater relative left-frontal EEG activity due to decreased right frontal activity. Specifically, reduced functioning of the right Inferior Frontal Gyrus (rIFG) was responsible for the association with positive urgency and increased left frontal asymmetry. Results of this study suggest that greater relative left-frontal activity may reflect the neural underpinnings of the supervisory control system.

The current study sought to investigate which personality system drives neurophysiological craving responses towards alcohol pictures. Specifically, the study examined whether trait impulsivity, trait approach, or trait avoidance moderates the link between asymmetrical frontal activation and alcohol cues. Participants completed measures of trait impulsivity and measures of trait approach/avoidance motivation before viewing both alcohol and neutral picture cues. Neurophysiological activity was recorded during picture viewing.

2. METHODOLOGY

Forty-two participants (29 females, 10 males, 3 did not report gender) completed the study in return for partial course credit.

Procedure

Participants completed the UPPS-P Behavioral Impulsivity Scale (Cyders et al. 2007), the BIS/BAS scales (Carver and White 1994), and general demographics including age, gender, and questions about their current drinking habits. After completing the demographic questions as well as the measures of impulsivity and approach/avoidance motivation, participants viewed 32 neutral pictures (rocks) and 32 alcohol pictures (alcoholic beverages such as beer, wine, and liquor). Each picture was displayed for 9 seconds and preceded by a 500ms fixation cross. EEG activity was recorded during picture presentation. Lastly, experimenters thoroughly debriefed participants and granted participation credits. The current study was approved by the IRB ethics committee and all participants were informed of their rights as participants before beginning the study.

Measures

Demographics.

Participants reported their sex (1= female, 2 = male). Participants also reported handedness by indicating whether they use their left, right, or either hand for 13 different behaviors (e.g., drawing). All participants reported being right handed.

UPPS-P Behavioral Impulsivity Scale.

The UPPS-P Behavioral Impulsivity Scale is a 59-item scale with five subscales measuring trait impulsivity. Each question is rated on a four point Likert Scale (1 = Agree Strongly; 4=Disagree Strongly). Higher scores on the UPPS-P indicate a higher level of impulsivity (Cyders et al. 2007). The first subscale, negative urgency, encompasses 12 items (e.g., "In the heat of an argument, I will often say things that I later regret"). Negative urgency refers to the tendency to act rashly when in a distressed state. The second subscale, lack of premeditation, is comprised of 11 items that gauge an individual's inability to consider the consequences of actions (e.g., "I am not one of those people who blurt out things without thinking"; item reverse scored). The third subscale, lack of perseverance, is comprised of 10 items and measures an inability to persist in completing tasks or committing to obligations (e.g., "I generally like to see things through to the end"; item reverse scored). The fourth subscale, sensation seeking, is 12 items and measures an individual's propensity for stimulation and excitement (e.g., "I generally seek new and exciting experiences and sensations"). Finally, the fifth subscale, positive urgency, is comprised of 14 items and measures the tendency to act rashly when experiencing high positive affect (e.g., "When I am in a great mood, I tend to get into situations that could cause me problems"). Means, standard deviations, and reliability scores for the UPPS-P and subscales can be found in Table 1.

Table 1
Descriptive Statistics and Reliabilities of Individual Difference Measures

Measure	Mean	Std. Dev	Cronbachs Alpha
BAS	2.97	0.38	0.81
BAS Reward Responsiveness	3.28	0.31	0.44
BAS Drive	2.67	0.52	0.76
BAS Fun	2.87	0.61	0.81
BIS	2.91	0.66	0.89
UPPS-P	2.87	0.39	0.93
Negative Urgency	2.87	0.54	0.84
Positive Urgency	3.23	0.46	0.92
Lack of Premeditation	2.93	0.47	0.89
Lack of Perseverance	3.12	0.43	0.84
Sensation Seeking	2.26	0.55	0.87

Trait BIS/BAS,

The BIS/BAS questionnaire contains one scale of BIS (behavioral inhibition) and three subscales of BAS (behavioral activation). The BIS scale component relates to the anticipation of punishment and is a measure of the avoidance motivation system. The BIS scale encompasses seven items (e.g., "I worry about making mistakes"). The three BAS scales include: BAS reward responsiveness, BAS drive, and BAS fun-seeking. BAS reward responsiveness looks at responses to the anticipation of reward across five items. BAS drive measures an individual's persistent pursuit of goals across four items. BAS fun-seeking measures an individual's willingness to approach new stimuli with the potential of reward across four items. The entire

BIS/BAS scale is 20 items (Carver and White 1994). Overall BAS is calculated by taking the average of the BAS subscale items. Means, standard deviations, and reliability scores for the BIS/BAS scales as well as the BAS subscales can be found in Table 1.

Drinking Habits.

Two questions measured past month drinking habits. Past month drinking was measured by asking participants "During the past month how many times have you had at least one drink of alcohol?" (referred to as "past month drinking"). The typical amount consumed during each instance of drinking was measured by asking participants "During the past month on the days you drank, on average, how many drinks did you have?" (labeled "past month amount"). Alcohol use was quantified using a product of monthly frequency and quantity. One participant did not report monthly frequency and another did not report quantity. Table 2 includes descriptive statistics concerning reported drinking habits.

Table 2
Descriptive Statistics for Reported Drinking Behaviors

Measure	Mean	Std. Dev	Min	Max
Past month drinking	6.39	7.84	0	40
Past month amount	2.83	2.82	0	12
Alcohol Use	22..23	30.22	0	126

Electroencephalography (EEG).

EEG activity was recorded using 64 electrodes embedded in a stretch lycra cap, placed according to the 10-20 system using known anatomical landmarks. Data was referenced to the left earlobe with a ground electrode mounted between FPZ and FZ sites (Electro-Caps, Eaton, OH). Electrode impedances were kept under 5,000 Ω for all sites and within 1,000 Ω for homologous electrode pairs. Signals from the electrodes were amplified using a Neuroscan

SynAmps RT amplifier unit (El Paso, TX), low-pass filtered at 100 Hz, high-pass filtered at 0.05 Hz, notch filtered at 60-Hz, and digitized at 2,000 Hz. Artifacts were removed from the data by hand. A regression-based eye movement correction was used to remove blinks and visual inspection of the data was performed to insure proper correction before the data were used for analyses (Semlitsch et al. 1986).

Consistent with previous research, frontal asymmetry was measured using alpha band power (Coan and Allen 2003; Harmon-Jones et al. 2010 for reviews) within the traditional alpha broadband range of 8 -13 Hz using a fast Fourier transformation (Shackman, et al. 2010). Alpha activity was averaged across the 9 seconds of picture presentation for each picture type. Power spectra epochs 1.024s in duration were extracted through a Hamming window (50% of taper of distal ends) and data were re-referenced using a common average reference. Asymmetry indexes were created for frontal homologous sites (F3/F4, F5/F6; log right minus log left; Gable and Harmon-Jones 2008). Because alpha power is inversely related to cortical activity higher index scores indicate greater left than right hemispheric activity (Lindsley and Wicke 1974).

3. RESULTS

Trait impulsivity, trait approach, and trait avoidance

Bivariate regression was used to determine if trait impulsivity, approach, or avoidance would predict neural correlates of cue-elicited craving (i.e., greater left frontal cortical activity to alcohol stimuli). Trait impulsivity predicted greater left frontal activation to alcohol pictures, *ß* = .43, $t(32) = 2.73$, $p = .01$, but not to neutral pictures, *ß* = .19, $t(32) = 1.08$, $p = .28$. Trait impulsivity explained a significant proportion of variance in asymmetric frontal activation to alcohol stimuli, $R^2 = .19$, $F(1, 32) = 7.46$, $p = .01$.

In order to investigate which facet of impulsivity is driving the relationship between trait impulsivity and greater left frontal cortical activity to alcohol stimuli, bivariate regression was used with each UPPS-P subscale. Lack of perseverance, sensation seeking, and positive urgency each failed to significantly predict greater left frontal activity to alcohol stimuli (*t's* < 1.8, *p's* > .05). However, both negative urgency *ß* = .39, $t(32) = 2.39$, $p = .02$, and lack of premeditation, *ß* = .41, $t(32) = 2.58$, $p = .02$, were significant predictors of greater left frontal activation to alcohol pictures. Lack of premeditation predicted a larger proportion of variance, $R^2 = .17$, $F(1, 32) = 6.65$, $p = .02$, than did negative urgency, $R^2 = .15$, $F(1, 32) = 5.71$, $p = .02$, although both predicted a significant proportion of variance in asymmetric frontal activity to alcohol stimuli. Table 3 reports all bivariate regression values.

Table 3

Bivariate Regression Results

Personality Measure	Left Frontal Activity to Alcohol Pictures	Left Frontal Activity to Neutral Pictures
BAS	.11	.11
BAS Reward Responsiveness	.13	-.02
BAS Drive	.24	.30
BAS Fun	-.05	-.01
BIS	.19	.10
UPPS-P	.43**	.19
Negative Urgency	.39*	.20
Positive Urgency	.18	.14
Lack of Premeditation	.41*	.24
Lack of Perseverance	.11	.07
Sensation Seeking	.30	.18

Notes. Beta values are reported in the table above; $*p < .05$, $**p < .01$

Trait approach motivation (BAS) did not predict greater left frontal activation to alcohol stimuli, $ß = .11$, $t(32) = 0.65$, $p = .52$, or greater left frontal activation to neutral stimuli, $ß = -.11$, $t(32) = 0.65$, $p = .52$. Similarly, all three BAS subscales failed to predict greater left frontal activation to alcohol as well as neutral stimuli, *ß's* < .24, *t's* < 1.75, *p's* > .05. Bivariate regression analyses also revealed that trait behavioral avoidance (BIS) did not predict greater left frontal activation to alcohol stimuli, $ß = .19$, $t(32) = 1.10$, $p = .28$, or greater left frontal activation to neutral stimuli, $ß = .10$, $t(32) = 0.58$, $p = .56$.

These results suggest that trait impulsivity, not trait approach or trait avoidance, is responsible for driving neural correlates of cue-elicited alcohol craving (i.e., greater left frontal cortical activation in response to alcohol stimuli). Specifically, it appears that decreased activation of the supervisory control system (increased trait impulsivity) is responsible for cue-elicited alcohol craving.

Co-variation and interactions

Multiple regression was used to determine if trait impulsivity continued to be a significant predictor of greater left frontal activation to alcohol pictures when neural responses to neutral pictures were held constant. The regression model shows that when neural responses to neutral pictures are controlled, trait impulsivity continues to be a significant predictor of greater left frontal cortical activation, $ß = .30$, $t(31) = 2.30$, $p = .01$. Multiple regression was also used to determine if controlling for drinking behaviors impacts the predictive power of trait impulsivity. Trait impulsivity remained a significant predictor of greater left frontal cortical activation when controlling for alcohol use, $ß = .45$, $t(30) = 2.34$, $p = .03$.

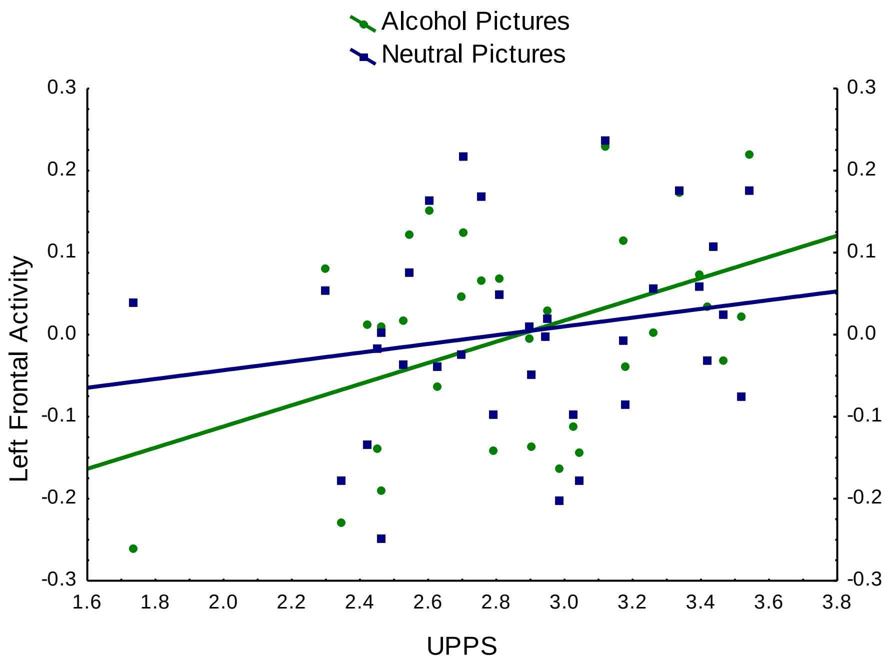
To further examine whether drinking behavior influences the relationship between impulsivity and alcohol-cue craving, non-drinkers (individuals who reported no instances of drinking in the past month, n = 12) were excluded from analyses. Trait impulsivity remained a significant predictor of left frontal activation in response to alcohol cues when individuals who reported not drinking in the past month were excluded from the analyses, $ß = .46$, $t(22) = 2.44$, $p = .02$.

To examine whether approach and avoidance systems influenced the relationship between impulsivity and alcohol-cue craving, we controlled for trait BAS and trait BIS. Trait impulsivity remained a significant predictor of greater left frontal cortical activation when controlling for trait approach, $ß = .52$, $t(31) = 3.18$, $p = .01$, as well as when trait avoidance was included in the model, , $ß = .44$, $t(30) = 2.46$, $p = .02$. Multiple regression including both trait approach and trait avoidance as predictors of greater left frontal activation produced a non-significant regression model, $ß = .20$, $t(30) = 1.11$, $p = .45$.

A repeated measures ANOVA revealed a significant interaction between trait impulsivity and greater left frontal activation as a function of picture type, F(1, 32) = 5.95, p = .02; η_p^2=0.16. Higher trait impulsivity scores predicted greater left frontal cortical activity to alcohol pictures (r=0.44, p = 0.01), but not to neutral pictures (r=0.19, p = 0.29), see Figure 1. These results suggest that trait impulsivity moderates the relationship between left frontal cortical activity and picture type.

Fig. 1

Interaction between Trait Impulsivity and Greater Left Frontal Activation as a Function of Picture Type



Drinking behaviors and gender

Drinking behaviors did not relate to neural activity in response to either picture type. Bivariate regression determined that alcohol use during the past month did not predict left frontal asymmetry to alcohol pictures, *ß* = .05, *t*(31) = .28, *p* = .78. Additionally, bivariate regression determined that alcohol consumption, during the past month did not predict left frontal asymmetry to neutral pictures ß = .07, $t(31) = .40$, $p = .69$. Finally, the effect of gender was investigated. According to t-tests conducted with the current sample, participant gender did not influence neural activity elicited by alcohol pictures, $t(28)= 1.36$, $p=0.18$, or neutral pictures, $t(28)=0.97$, $p=0.34$.

4. DISCUSSION

The current study establishes a connection between reduced functioning of the supervisory control system and cue-elicited alcohol cravings using neurophysiological measures of frontal asymmetry. Results revealed that reduced functioning of the supervisory control system predicted greater left-frontal activation towards alcohol cues. Increased trait impulsivity remained a predictor of left-frontal activation towards alcohol cues when controlling for drinking behaviors and neural activation to neutral pictures. Furthermore, results from the current study show that impulsivity is a moderator of the relationship between asymmetrical activation and picture type. Study results did not find a relationship between trait approach or trait avoidance and the neurophysiological measures of cue-elicited alcohol craving. It appears that reduced functioning of the supervisory control system moderates cue-elicited alcohol craving, but not the approach or avoidance motivation systems.

Research on cue-elicited alcohol cravings has shown that the experience of craving is predictive of alcohol consumption and predictive of relapse for recovering alcoholics (Flannery et al. 2001). Understanding that the reduced functioning of the supervisory control system is a mechanism behind cue-elicited alcohol craving can help identify those who may be at high risk for consumption. The craving towards alcohol cues may be especially salient to those high in trait impulsivity. Increasing control efficacy and reducing impulsive tendencies may be effective in reducing cue-elicited alcohol cravings and the neural responses to alcohol cues.

Trait impulsivity predicts a variety of risky behaviors. Much of the previous research on impulsivity and alcohol investigates how these risky behaviors are associated with this relationship. For example, pathological gambling and risky sexual behaviors are shown to accompany the relationship between increased trait impulsivity and alcohol use (Petry 2001; Stuhldreher et al. 2007; Walker et al. 2012). Impulsive individuals are also more likely to over consume alcohol (i.e., binge drink) resulting in negative health outcomes (Balodis et al. 2009). State asymmetrical responses to alcohol cues may contribute to the promotion of other risky behaviors associated with alcohol.

Inhibitory functions are responsible for regulating immediate affective responses to stimuli and rely heavily on the executive function of the prefrontal cortex. Because affective states are integrally involved with impulsivity (Cyders et al. 2007), it may be that impulsivity-moderated alcohol cue craving is related to an affective response to the alcohol related stimuli. Past work has found that emotion-based craving is related to increased trait impulsivity (Joos et al. 2013). In the absence of a functioning supervisory control system (increased impulsivity), affective reactions may be strengthened, resulting in increased cravings. Impulsive individuals may be less able to call upon executive control when confronted with desirable stimuli, leading to increased cravings (Doran et al. 2007). Further research is needed to clarify how the supervisory control system may be moderating frontal activation to alcohol cues

Previous research has identified a relationship between BAS and cue-elicited alcohol craving (Cox 1988; Verheul et al. 1999), our results did not find a relationship between trait BAS and frontal asymmetry in response to alcohol cues. Activity of the supervisory control system and behavioral activation systems may influence different components of substance use. For example, impulsivity relates to rash action without forethought, while BAS relates to a purposeful reward-sensitive drive to obtain stimuli (Dawe and Loxton 2004). Substance use likely engages both a purposeful goal-directed planning as well as rash action. However, cue-evoked frontal activation appears to be driven more by rash spontaneous action.

The current study identified negative urgency and lack of premeditation as specific components driving the relationship between trait impulsivity and the neural correlates of cue-elicited alcohol cravings. Some theorists have proposed that lack of premeditation taps the core rash impulsivity trait observed in substance use studies (Gullo et al. 2014). Negative Urgency also taps core impulsivity, but may also tap facets of neuroticism. Based on their meta-analysis of studies examining the UPPSP subscales, Gullo and colleagues (2014) conclude that "only (Lack of) Premeditation and Negative Urgency are consistently associated with substance use" (Gullo et al. 2014 p.1550). Results of the current study support this conclusion.

The present study found a relationship between reduced functioning of the supervisory control system and neurophysiological underpinnings of cue-elicited alcohol craving. The relationship between impulsivity and frontal asymmetry remained when non-drinkers were excluded from the analyses. The lack of a relationship between drinking and greater left frontal activation in response to alcohol cues may have been the product of limitations concerning our sample. The current sample was lacking in heavy drinkers and consisted mainly of underage students who reported light drinking habits. Future research would benefit from recruiting individuals who report heavy drinking habits and/or a history of alcohol dependence in order to strengthen the clinical applications of these results. In addition, the study design may have impacted this null effect, because participants reported recent drinking using two self-report items concerning the frequency and amount of alcohol consumed over the past month. Perhaps more detailed measures of alcohol use, such as the Timeline Followback measure, would be more sensitive to the variance in assessing alcohol use (Robinson et al. 2014; Sobell, L. and Sobell, M 1995).

However, the link between impulsivity and left frontal activation may not be entirely dependent on previous drinking experience. Alcohol use over the past month did not relate to left frontal activation in response to alcohol pictures. The positive associations with alcohol such as enhanced social status, enhanced social bonding, greater perceived attraction and sexual encounters may influence the neural correlates of cue-elicited alcohol craving (Fromme et al. 1993; Kuntsche et al. 2005). Such associations could be learned through media exposure and advertisements, which can occur independently of alcohol consumption. This would suggest that for some individuals, no previous drinking experience is necessary to have an appetitive response to alcohol cues.

In sum, reduced functioning of the supervisory control system appears to be responsible for the neurophysiological responses underlying cue-elicited alcohol cravings. The neural correlates of cue-elicited alcohol cravings are being driven by trait impulsivity. Trait impulsivity moderates the relationship between frontal asymmetry and picture type. The purpose of the supervisory control system is to regulate the impulses that are produced by the approach and avoidance systems. Failure of the supervisory control system to inhibit these impulses allows for the potential of maladaptive behaviors. The current research has shown that reduced functioning of the supervisory control system is responsible for the neural correlates of cue-elicited alcohol cravings. These results contribute to a growing body of literature that aims to identify the neurophysiological correlates and markers of individual differences in personality systems (Nusslock et al. 2012; Cyders et al. 2014; Gable et al., in press; Hicks et al. 2015).

REFERENCES

Amodio, DM, Master, SL, Yee, CM., Taylor, SE (2008) Neurocognitive components of the behavioral inhibition and activation systems: Implications for theories of self-regulation. Psychophysiology 45:11-19.

Aron, AR, Robbins, TW, Poldrack, RA (2004) Inhibition and the right inferior frontal cortex. Trends Cogn Sci 8: 170-177.

Aron, AR, Robbins, TW, Poldrack, RA (2014) Inhibition and the right inferior frontal cortex: One decade on. Trends Cogn Sci 18: 177-185.

Balodis, IM, Potenza, MN, Olmstead, MC (2009) Binge drinking in undergraduates: Relationships with gender, drinking behaviors, impulsivity and the perceived effects of alcohol. Behav Pharmacol 20: 518-526.

Boggio, PS, Sultani, N, Fecteau, S, Merabet, L, Mecca T, Pascual-Leone, A, Basaglia, A, Fregni, F (2007) Prefrontal cortex modulation using transcranial DC stimulation reduces alcohol craving: A double-blind, sham-controlled study. Drug Alcohol Depend 92: 55-60.

Broca, P (1861) Remarques sur la siege de la faculté du langage articulé, suivies d'une observation d'aphémie. Bulletin de la Société Anatomique de Paris 2: 330-357.

Canan, F, Ataoglu, A (2008) Panic disorder after the end of chronic alcohol abuse: A report of 2 cases. Prim Care Companion J Clin Psychiatry 10: 332-333.

Carpenter, KM, Hasin, DS (1998) Reasons for drinking alcohol: Relationships with DSM-IV alcohol diagnoses and alcohol consumption in a community sample. Psychol Addict Behav 12: 168-184.

Carter, BL, Tiffany, ST (1999) Meta-analysis of cue-reactivity in addiction research. Addiction 94: 327-340.

Carver, CS, Connor-Smith, J (2010) Personality and coping. Annu Rev Psychol 61: 679-704.

Carver, CS, Scheier, MF (2008) Feedback processes in the simultaneous regulation of action and affect. In: Shah JY and Gardner WL (Eds.), Handbook of Motivation Science. Guilford Press, New York, pp 308-324

Carver, CS, White, TL (1994) Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: the BIS/BAS scales. J Pers Soc Psychol 67: 319-333.

Coan, JA, Allen, JJ (2003) Frontal EEG asymmetry and the behavioral activation and inhibition systems. Psychophysiology 40: 106-114.

Cooney, NL, Litt, MD, Morse, PA, Bauer, LO, Gaupp, L (1997) Alcohol cue reactivity, negative-mood reactivity, and relapse in treated alcoholic men. J Abnorm Psychol 106: 243-250.

Cooper, ML, Russell, M, Skinner, JB, Windle, M (1992) Development and validation of a three-dimensional measure of drinking motives. Psychol Assess 4: 123-132.

Cox, WM, Klinger, E (1988) A motivational model of alcohol use. J Abnorm Psychol 97: 168-180.

Cyders, MA, Dzemidzic, M, Eiler, WJ, Coskunpinar, A, Karyadi, KA, Kareken, DA (2014) Negative urgency mediates the relationship between amygdala and orbitofrontal cortex activation to negative emotional stimuli and general risk-taking. Cereb Cortex bhu123.

Cyders, MA, Smith, GT (2008) Emotion-based dispositions to rash action: positive and negative urgency. Psychol Bull 134: 807-828.

Cyders, MA, Smith, GT, Spillane, NS, Fischer, S, Annus, AM, Peterson, C (2007) Integration of impulsivity and positive mood to predict risky behavior: development and validation of a measure of positive urgency. Psychol Assess 19: 107-118.

Davidson, RJ, Ekman, P, Saron, CD, Senulis, JA, Friesen, WV (1990) Approach-withdrawal and cerebral asymmetry: Emotional expression and brain physiology: I. J Pers Soc Psychol 58: 330-341.

Dawe, S, Loxton, NJ (2004) The role of impulsivity in the development of substance use and eating disorders. Neurosci Biobehav Rev, 28: 343-351.

Del Boca, FK, Darkes, J, Greenbaum, PE, Goldman, MS (2004) Up close and personal: temporal variability in the drinking of individual college students during their first year. J Consult Clin Psychol 72: 155-164.

Depue, RA, Collins, PF (1999) Neurobiology of the structure of personality: Dopamine, facilitation of incentive motivation, and extraversion. Behav Brain Sci 22: 491-517.

Doran, N, Spring, B, McChargue, D (2007) Effect of impulsivity on craving and behavioral reactivity to smoking cues. Psychopharmacology 194: 279-288.

Elliot, AJ (2008) Handbook of approach and avoidance motivation. Taylor and Francis, London

Enticott, PG, Ogloff, JR, Bradshaw, JL (2006) Associations between laboratory measures of executive inhibitory control and self-reported impulsivity. Pers Individ Dif 41: 285-294.

Field, M, Cox, WM (2008) Attentional bias in addictive behaviors: A review of its development, causes, and consequences. Drug Alcohol Depend 97: 1-20.

Flannery, BA, Roberts, AJ, Cooney, N, Swift, RM, Anton, RF, Rohsenow, DJ (2001) The role of craving in alcohol use, dependence, and treatment. Alcohol Clin Exp Res 25: 299-308.

Friedman, RS, McCarthy, DM, Bartholow, BD, Hicks, JA (2007) Interactive effects of alcohol outcome expectancies and alcohol cues on nonconsumptive behavior. Exp Clin Psychopharmacol 15: 102-114.

Friedman, RS, McCarthy, DM, Förster, J, Denzler, M (2005) Automatic effects of alcohol cues on sexual attraction. Addiction 100: 672-681.

Fromme, K, Stroot, EA, Kaplan, D (1993) Comprehensive effects of alcohol: Development and psychometric assessment of a new expectancy questionnaire. Psychol Assess 5: 19-26.

Gable, P, Harmon-Jones, E (2008) Relative left frontal activation to appetitive stimuli: Considering the role of individual differences. Psychophysiology 45: 275-278.

Gable, PA, Mechin, N, Hicks, JA, Adams, D (in press) Supervisory control system and frontal asymmetry: Neurophysiological traits of emotion-based impulsivity Soc Cogn Affect Neurosci

Garland, EL, Gaylord, SA, Boettiger, CA, Howard, MO (2010) Mindfulness training modifies cognitive, affective, and physiological mechanisms implicated in alcohol dependence: Results of a randomized controlled pilot trial. J Psychoactive Drugs 42: 177-192.

Gazzaniga, MS (1985) *The social brain: Discovering the networks of the mind*. Basic Books, New York

George, MS, Anton, RF, Bloomer, C, Teneback, C, Drobes, DJ, Lorberbaum, JP, Nahas, Z, Vincent, DJ (2001) Activation of prefrontal cortex and anterior thalamus in alcoholic subjects on exposure to alcohol-specific cues. Arch Gen Psychiatry 58: 345–352.

Gianotti, LR, Knoch, D, Faber, PL, Lehmann, D, Pascual-Marqui, RD, Diezi, C, Schnoch, C, Eisenegger, C, Fehr, E (2009) Tonic activity level in the right prefrontal cortex predicts individuals' risk taking. Psychol Sci 20: 33-38.

Goldstein, K (1939) The organism: A holistic approach to biology derived from pathological data in man. American Book Publishing, Salt Lake City

Goldstein, RZ, Volkow, ND (2002) Drug addiction and its underlying neurobiological basis: Neuroimaging evidence for the involvement of the frontal cortex. Am J Psychiatry 159: 1642-1652.

Gordon, S. M., Sterling, R., Siatkowski, C., Raively, K., Weinstein, S., and Hill, P. C. (2006). Inpatient desire to drink as a predictor of relapse to alcohol use following treatment. Am J Addict, 15(3), 242-245.

Grant, BF, Harford, TC (1995) Comorbidity between DSM-IV alcohol use disorders and major depression: Results of a national survey. Drug Alcohol Depend 39: 197-206.

Gray, JA (1970) The psychophysiological basis of introversion-extraversion. Behav Res Ther 8: 249-266.

Gray, JA (1987) The psychology of fear and stress. Cambridge University Press, Cambridge

Gray, JA, McNaughton, N (2000) The neuropsychology of anxiety: An enquiry into the functions of the septo-hippocampal system. Oxford University Press, Oxford

Grimshaw, GM, Carmel, D (2014) An asymmetric inhibition model of hemispheric differences in emotional processing. Front Psychol 5: 489.

Gullo, MJ, Loxton, NJ, Dawe, S (2014) Impulsivity: four ways five factors are not basic to addiction. Addict Behav 39: 1547-1556.

Han, DH, Bolo, N, Daniels, MA, Arenella, L, Lyoo, IK, Renshaw, PF (2011) Brain activity and desire for Internet video game play. Compr Psychiatry 52: 88-95.

Harmon-Jones, E (2003) Clarifying the emotive functions of asymmetrical frontal cortical activity. Psychophysiology 40: 838-848.

Harmon-Jones, E, Gable, PA (2009) Neural activity underlying the effect of approach-motivated positive affect on narrowed attention. Psychol Sci 20: 406-409.

Harmon-Jones, E, Gable, PA, Peterson, CK (2010) The role of asymmetric frontal cortical activity in emotion-related phenomena: A review and update. Biol Psychol 84: 451-462.

Harmon-Jones, E, Sigelman, J (2001) State anger and prefrontal brain activity: evidence that insult-related relative left-prefrontal activation is associated with experienced anger and aggression. J Pers Soc Psychol 80: 797-803.

Hicks, JA, Fields, S, Davis, WE, Gable, PA (2015) Heavy drinking, impulsivity and attentional narrowing following alcohol cue exposure. Psychopharmacology 1-7.

Hicks, JA, Friedman, RS, Gable, PA, Davis, WE (2012) Interactive effects of approach motivational intensity and alcohol cues on the scope of perceptual attention. Addiction 107: 1074-1080.

Joos, L, Goudriaan, AE, Schmaal, L, De Witte, NAJ, Van den Brink, W, Sabbe, BGC, Dom, G (2013) The relationship between impulsivity and craving in alcohol dependent patients. Psychopharmacology 226: 273-283.

Kochanska, G, Knaack, A (2003) Effortful control as a personality characteristic of young children: Antecedents, correlates, and consequences. J Pers 71: 1087-1112.

Kuntsche, E, Knibbe, R, Gmel, G, Engels, R (2005) Why do young people drink? A review of drinking motives. Clin Psychol Rev 25: 841-861.

Kushner, MG, Thuras, P, Abrams, K, Brekke, M, Stritar, L (2001) Anxiety mediates the association between anxiety sensitivity and coping-related drinking motives in alcoholism treatment patients. Addict Behav 26: 869-885.

Leeman, RF, Bogart, D, Fucito, LM, Boettiger, CA (2014) "Killing two birds with one stone": Alcohol use reduction interventions with potential efficacy at enhancing self-control. Curr Addict Rep 1: 41-52.

Lindsley, DB, Wicke, JD (1974) The electroencephalogram: Autonomous electrical activity in man and animals. In: Thompson R, Patterson MN (Eds.), Bioelectric recording techniques. Academic Press, New York, pp 3-79

Logan, GD, Schachar, RJ, Tannock, R (1997) Impulsivity and inhibitory control. Psychol Sci 8: 60-64.

McClernon, FJ, Hiott, FB, Huettel, SA, Rose, JE (2005) Abstinence-induced changes in self-report craving correlate with event-related FMRI responses to smoking cues. Neuropsychopharmacology 30: 1940-1947.

Myrick, H, Anton, RF, Li, X, Henderson, S, Drobes, D, Voronin, K, George, MS (2004) Differential brain activity in alcoholics and social drinkers to alcohol cues: Relationship to craving. Neuropsychopharmacology 29: 393-402.

Nigg, JT (2006) Temperament and developmental psychopathology. J Child Psychol Psychiatry 47: 395-422.

Nusslock, R, Harmon-Jones, E, Alloy, LB, Urosevic, S, Goldstein, K, Abramson, LY (2012) Elevated left mid-frontal cortical activity prospectively predicts conversion to bipolar I disorder. J Abnorm Psychol 121: 592-601.

Papachristou, H, Nederkoorn, C, Havermans, R, van der Horst, M, Janse, A (2012) Can't stop the craving: The effect of impulsivity on cue-elicited craving for alcohol in heavy and light social drinkers. Psychopharmacology 219: 511-518.

Perry, JL, Carroll, ME (2008) The role of impulsive behavior in drug abuse. Psychopharmacology 200: 1-26.

Petry, NM (2001) Pathological gamblers, with and without substance abuse disorders, discount delayed rewards at high rates. J Abnorm Psychol 110: 482-487.

Robinson, SM, Sobell, LC, Sobell, MB, Leo, GI (2014) Reliability of the Timeline Followback for cocaine, cannabis, and cigarette use. Psychol Addict Behav 28: 154-162.

Rossi, GF, Rosadini, G (1967) Experimental analysis of cerebral dominance in man. Brain Mechanisms Underlying Speech and Language: 167-184.

Rothbart, MK, Rueda, MR (2005) The development of effortful control. In: Mayr U, Awh E, Keele SW (Eds.) Developing Individuality in the human brain: A tribute to Michael I. Posner. American Psychological Association, Washington, pp 167-188

Santesso, DL, Segalowitz, SJ, Ashbaugh, AR, Antony, MM, McCabe, RE, Schmidt, LA (2008) Frontal EEG asymmetry and sensation seeking in young adults. Biol Psychol 78: 164-172.

Shackman, AJ, McMenamin, BW, Maxwell, JS, Greischar, LL, Davidson, RJ (2010) Identifying robust and sensitive frequency bands for interrogating neural oscillations. Neuroimage 51: 1319-1333.

Semlitsch, HV, Anderer, P, Schuster, P, Presslich, O (1986) A solution for reliable and valid reduction of ocular artifacts, applied to the P300 ERP. Psychophysiology 23: 695-703.

Sobotka, SS, Davidson, RJ, Senulis, JA (1992) Anterior brain electrical asymmetries in response to reward and punishment. Electroencephalogr Clin Neurophysiol 83: 236-247.

Sperry, RW, Gazzaniga, MS, Bogen, JE (1969) Interhemispheric relationships: The neocortical commissures, syndromes of hemispheric disconnection. In: Vinken PJ, Bruyn GW (Eds.) Handbook of clinical neurology, vol. 4: Disorders of speech, perception, and symbolic behavior. Elsevier/North Holland Biomedical Press, Holland, pp 145-153

Stuhldreher, WL, Stuhldreher, TJ, Forrest, KY (2007) Gambling as an emerging health problem on campus. J Am Coll Health 56: 75-88.

Sutton, SK, Davidson, RJ (1997) Prefrontal brain asymmetry: A biological substrate of the behavioral approach and inhibition systems. Psychol Sci 8: 204-210.

Tapert, SF, Brown, CG, Baratta, MV, Brown, SA (2004) fMRI BOLD response to alcohol stimuli in alcohol dependent young women. Addict Behav 29: 33-50.

Tapert, SF, Cheung, EH, Brown, GG, Frank, LR, Paulus, MP, Schweinsburg, AD, Meloy, MJ, Brown, SA (2003) Neural response to alcohol stimuli in adolescents with alcohol use disorder. Arch Gen Psychiatry 60: 727-735.

Toga, AW, Thompson, PM (2003) Mapping brain asymmetry. Nat Rev Neurosci 4: 37-48.

Van de Laar, MC, Licht, R, Franken, IHA, Hendriks, VM (2004) Event-related potentials indicate motivational relevance of cocaine cues in abstinent cocaine addicts. Psychopharmacology 177:121-129.

Verheul, R, van der Brink, W, Geerlings, P (1999) A three-way psychobiological model of craving for alcohol. Alcohol Alcohol 34: 197-222.

Walker, DM, Clark, C, Folk, JL (2012) The relationship between gambling behavior and binge drinking, hard drug use, and paying for sex. UNLV Gaming Research and Review Journal 14: 15-26.

Witkiewitz, K, Bowen, S (2010) Depression, craving, and substance use following a randomized trial of mindfulness-based relapse prevention. J Consult Clin Psychol 78: 362-374.

Wrase, J, Grüsser, SM, Klein, S, Diener, C, Hermann, D, Flor, H, Mann, DF, Heinz, A (2002) Development of alcohol-associated cues and cue-induced brain activation in alcoholics. Eur Psychiatry 17: 287-291.

Zisserson, RN, Palfai, TP (2007) Behavioral activation system (BAS) sensitivity and reactivity to alcohol cues among hazardous drinkers. Addict Behav 32: 2178-2186.

APPENDIX A

IRB Certification

Office for Research

Institutional Review Board for the Protection of Human Subjects

THE UNIVERSITY OF ALABAMA RESEARCH

January 9, 2015

Philip Gable, Ph.D.
Department of Psychology
College of Arts and Sciences
The University of Alabama
Box 870348

Re: IRB # 13-OR-140-R2 "Attention and Appetitive Motivation"

Dear Dr. Gable:

The University of Alabama Institutional Review Board has granted approval for your renewal application.

Your renewal application has been given expedited approval according to 45 CFR part 46. You have also been granted the requested waiver of informed consent. Approval has been given under expedited review category 7 as outlined below:

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Your application will expire on January 8th 9, 2016. If your research will continue beyond this date, complete the relevant portions of the IRB Renewal Application. If you wish to modify the application, complete the Modification of an Approved Protocol Form. Changes in this study cannot be initiated without IRB approval, except when necessary to eliminate apparent immediate hazards to participants. When the study closes, complete the appropriate portions of the IRB Study Closure Form.

Please use reproductions of the IRB stamped documents.

Should you need to submit any further correspondence regarding this prop

Goo

Sincerely,

Carpantato T. Myles, MSM, CIM, CIP
Director of Research Compliance & Research Compliance Officer
Office of Research Compliance

358 Rose Administration Building
Box 870127
Tuscaloosa, Alabama 35487-0127
(205) 348-8461
FAX (205) 348-7189
TOLL FREE (877) 820-3066