

PURDUE UNIVERSITY
GRADUATE SCHOOL
Thesis/Dissertation Acceptance

This is to certify that the thesis/dissertation prepared

By Kenny Ananda Karyadi

Entitled

THE INTERACTIVE EFFECTS OF ALCOHOL CRAVINGS, CUE REACTIVITY, AND
URGENCY ON COLLEGE STUDENT PROBLEMATIC DRINKING

For the degree of Master of Science

Is approved by the final examining committee:

Melissa A. Cyders

Chair

Catherine Mosher

Jesse Stewart

To the best of my knowledge and as understood by the student in the *Research Integrity and Copyright Disclaimer (Graduate School Form 20)*, this thesis/dissertation adheres to the provisions of Purdue University's "Policy on Integrity in Research" and the use of copyrighted material.

Approved by Major Professor(s): Melissa A. Cyders

Approved by: Nicholas J. Grahame

Head of the Graduate Program

03/07/2013

Date

THE INTERACTIVE EFFECTS OF ALCOHOL CRAVINGS, CUE REACTIVITY,
AND URGENCY ON COLLEGE STUDENT PROBLEMATIC DRINKING

A Thesis

Submitted to the Faculty

of

Purdue University

by

Kenny Ananda Karyadi

In Partial Fulfillment of the

Requirements for the Degree

of

Master of Science

May 2013

Purdue University

Indianapolis, Indiana

ACKNOWLEDGEMENTS

I would like to thank my mentor, Dr. Melissa A. Cyders, for her guidance throughout the entire process. I would also like to thank you my committee members, Drs. Jesse Stewart and Catherine Mosher, for their expertise and feedback.

TABLE OF CONTENTS

	Page
ABSTRACT	iv
INTRODUCTION	1
The Moderating Role of Urgency	3
The Moderating Role of Cue Reactivity	4
Cue Reactivity and Urgency as Moderators	6
Aims of the Study	7
METHOD	8
Participants and Data Restrictions	8
Measures and Materials	10
Urgency	10
Problematic Alcohol Use	11
Alcohol Cravings and Cue Reactivity	12
Pictorial Cues and Assessment	13
Procedure	13
Analytic Strategy	14
RESULTS	16
Initial Analyses	16
Interaction Analyses	17
DISCUSSION	19
General Discussion	19
Interaction between Urgency and Alcohol Cravings	20
Interaction between Cue Reactivity and Alcohol Cravings	22
Three-Way Interactions	23
Methodological, Sample, and Data Limitations	25
General Study Limitations	28
Future Directions	29
Conclusions	31
REFERENCES	32
APPENDICES	
Appendix A: Differences among Variables	41
Appendix B: T-Tests, Correlations, and Simultaneous Regression	43
Appendix C: Main Results	46
Appendix D: Interaction Figures	49

ABSTRACT

Karyadi, Kenny Ananda M.S., Purdue University, May 2013. The Interactive Effects of Alcohol Cravings, Cue Reactivity, and Urgency on College Student Problematic Drinking. Major Professor: Melissa A. Cyders.

Prior research indicated a high prevalence of problematic drinking among college students, suggesting a need for more effective screening approaches and treatments. The tendency to act rashly in face of strong emotions (e.g. positive and negative urgency), alcohol cravings, and cue reactivity all have been associated with problematic alcohol use. However, no studies have examined the interactive effects of alcohol cravings, urgency, and cue reactivity. I hypothesized that alcohol cravings will be associated with greater problematic drinking among individuals with higher levels of (1) urgency, (2) cue reactivity, and (3) cue reactivity and urgency. Data were collected from a sample (final $n = 240$) of college students through a survey, which consisted of measures of urgency, problematic drinking, and alcohol cravings. On the survey, participants were also exposed to alcohol and non-alcohol pictures, after which they assessed their level of cue reactivity. Results were examined using multiple regression and simple slope analyses. Results provided partial support for our hypotheses. Alcohol cravings were associated with greater problematic drinking at lower levels of negative urgency ($b = 7.36, p < 0.001$). Furthermore, alcohol cravings were most strongly associated with problematic

drinking at high levels of cue reactivity and low levels of negative urgency ($b = 8.69$, $p < 0.001$), and at low levels of cue reactivity and high levels of positive urgency ($b = 6.56$, $p < 0.001$). These findings emphasize the importance of considering urgency and cue reactivity in understanding how alcohol cravings create risk for problematic drinking.

INTRODUCTION

Prior studies have indicated a high prevalence of problematic drinking among college students (Blanco et al., 2008; Hingson, Heeren, Winter, & Wechsler, 2005; Hingson, Zha, & Weitzman, 2009; White et al., 2006). In particular, there has been an increase in the prevalence of driving under the influence, alcohol-related deaths, alcohol-related physical and sexual assaults, and binge drinking (Hingson et al., 2005; Hingson et al., 2009). In addition, 31% of students endorsed criteria for alcohol abuse and 6% of students endorsed criteria for alcohol dependence (Knight et al., 2002). However, despite the high prevalence of drinking problems in this population, few college students seek treatment for alcohol use disorders (Blanco et al., 2008; Knight et al., 2002). Taken together, these findings suggest the need to identify factors that contribute to problematic drinking among college students, and to consequently develop more effective screening methods and treatments for college students' problematic drinking.

Alcohol cravings, or urge to drink, might serve as an indicator of problematic drinking among college students. In particular, the presence of alcohol cravings has been suggested as a factor that maintains problematic patterns of alcohol use (Rohsenow & Monti, 1999). However, prior findings regarding the alcohol cravings-problematic drinking association have been mixed. Some studies have indicated that alcohol cravings were associated with higher levels of problematic alcohol use (Miller, Westerberg,

Harris, & Tonnigan, 1996; Monti et al., 1990), whereas other studies have indicated that alcohol cravings were either not associated (Cooney, Litt, Morse, Bauer, & Gaupp, 1997; Rohsenow et al., 1994) or were negatively associated with problematic alcohol use (Drummond & Glautier, 1994; Monti et al., 1990). These inconsistencies suggest that there are moderating factors that might influence the alcohol cravings-problematic alcohol use association.

In prior studies, alcohol cravings have been assessed using self-report measures of trait alcohol cravings (Anton, Moak, & Latham, 1995), self-report measures of state alcohol cravings (Bohn, Krahn, & Staehler, 1995), psychophysiological measures (Drummond & Glautier, 1994), and behavioral measures (Davidson, Palfai, Bird, & Swift, 1999). Through these different measurements, alcohol cravings might produce different effects on problematic drinking. For instance, prior studies found that state alcohol cravings were insignificantly or weakly associated with alcohol use behaviors, while trait alcohol cravings were more strongly associated with alcohol use behaviors (Drobes & Thomas, 1999). Furthermore, when alcoholics are assessed for alcohol cravings, self-report measures tend to produce greater levels of alcohol cravings compared to psychophysiological measures (Carter & Tiffany, 1999). While it is important to consider type of alcohol cravings assessment, the present study did not focus on type of assessment as a possible moderating factor. Instead, the present study examined reactivity to alcohol cues (cue reactivity) and the tendency to behave rashly in face of strong emotional states (urgency) as two possible moderating factors.

The Moderating Role of Urgency

Urgency refers to the tendency to behave impulsively in the face of strong negative emotions (negative urgency) and positive emotions (positive urgency). These specific impulsivity dispositions have been consistently shown to be direct risk factors for college student problematic alcohol use (Cyders et al., 2007; Cyders, Flory, Rainer, & Smith, 2009; Fischer, Anderson, & Smith, 2004; Smith et al., 2007). Among individuals who are high on urgency, efforts to address the experience of strong emotions tend to deplete cognitive resources dedicated to decision making processes, and might consequently make these individuals more likely to focus on their immediate emotional needs often without regards for long-term consequences (Cyders & Smith, 2008; Cyders et al., 2007; Cyders & Coskunpinar, 2010). Specifically, this increased focus on emotional needs might drive risky alcohol use behaviors as a means of enhancing positive affect or alleviating negative affect, and might consequently result in negative alcohol consequences (Cooper, Frone, Russell, & Mudar, 1995; Cyders et al., 2009; Fischer et al., 2004; Smith et al., 2007).

Considering that alcohol cravings have been shown to have a strong emotional component (Fox, Bergquist, Hong, & Sinha, 2007; Sinha et al., 2009), the experience of strong emotions among individuals high on urgency might also produce higher alcohol cravings (Doran, Spring, & McChargue, 2007; Pavlick, 2007). The alcohol cravings experienced by these individuals might reflect their desire to ameliorate negative affect (Doran, Cook, McChargue, & Spring, 2009; Smith et al., 2007) or to enhance positive affect (Cyders et al., 2007; Cyders et al., 2009). Moreover, because these individuals are more likely to focus on their immediate emotional needs when experiencing strong

emotions (Cyders & Smith, 2008), they might be at increased risk for problematic alcohol use because they would have a harder time resisting their cravings (Cyders et al., 2007; Smith et al., 2007). In this way, the effect of higher alcohol cravings might be more consistent among individuals high on urgency.

Pavlick (2007) found that binge drinking college students who are high on negative urgency also tended to be higher on alcohol cravings. Moreover, because both urgency facets are moderately correlated and reflect an underlying dysfunction in the ability to regulate emotions (Cyders et al., 2007), binge drinking college students high on positive urgency might also be higher on alcohol cravings. These findings suggest that both alcohol cravings and urgency exert a conjunctive influence on problematic drinking, but no studies have directly examined the interaction between urgency and alcohol cravings. The first aim of the present study was to examine the interaction between urgency and alcohol cravings on problematic alcohol use. Based on the findings by Pavlick (2007), I hypothesized that alcohol cravings would be associated with increased problematic drinking at higher levels of urgency.

The Moderating Role of Cue Reactivity

Prior studies have indicated that exposure to alcohol cues was associated with increased alcohol cravings (Fox et al., 2007; Mason, Light, Escher, & Drobles, 2008), suggesting enhanced reactivity to alcohol cues. There are learning processes that might account for this enhanced reactivity to alcohol cues. First, these alcohol cues can come to induce alcohol cravings after being repeatedly paired with unconditioned alcohol withdrawal symptoms (Wikler, 1973). Second, after becoming repeatedly paired with

alcohol's effects, these cues might come to elicit opposite effects that prepare the body for alcohol consumption and that might be experienced as alcohol cravings (Siegel, 1983). Finally, alcohol cues can become paired with alcohol's positive effects and might consequently become highly salient conditioned incentives (Field, Mogg, & Bradley, 2005) that can trigger alcohol cravings. Due to these processes, problematic drinkers might have enhanced reactivity to these cues and might consequently indicate higher levels of cravings.

Although no studies have directly examined the interaction between alcohol cravings and cue reactivity on problematic drinking, prior studies have lent support for the possibility of this type of interaction. For instance, exposure to alcohol odors was associated with increased alcohol cravings among alcohol dependent participants (Pomerleau, Fertig, Baker, & Cooney, 1983) and social drinkers (Stormark, Laberg, Bjerland, Nordby, & Hugdahl, 1995). Furthermore, among high risk drinkers, exposure to olfactory and visual alcohol cues was associated with greater desire to drink (Kareken et al., 2004). Finally, the cue exposure-alcohol cravings association is most prominent among individuals with problematic levels of alcohol use (Fox et al., 2007; Kareken et al., 2004; Mason et al., 2008; Pomerleau et al., 1983).

Taken together, reactivity to alcohol cues and alcohol cravings are often present among problematic drinkers. It might be that alcohol cravings are more consistently predictive of problematic drinking among individuals who are more reactive to alcohol cues. The second aim of the present study was to examine whether cue reactivity might interact with alcohol cravings on problematic alcohol use. Based on prior findings indicating enhanced cue reactivity among problematic drinkers (Kareken et al., 2004;

Pomerleau et al., 1983), I hypothesized that alcohol cravings will be more strongly associated with increased problematic drinking among individuals who are higher on cue reactivity.

Cue Reactivity and Urgency as Moderators

According to the Acquired Preparedness model of drinking, urgency can influence the formation of alcohol specific learning through its association with increased problematic drinking (Settles, Cyders, & Smith, 2010). Specifically, due to higher rates of drinking among individuals high on urgency (Cyders et al., 2007; Smith et al., 2007), these individuals might become more likely to acquire enhanced reactivity to alcohol cues through learning processes. Indeed, Pavlick (2007) found that binge drinking college students high on negative urgency reported higher levels of alcohol cravings when exposed to alcohol cues. Moreover, considering that positive urgency and negative urgency reflect a broad dysfunction in the ability to regulate emotions (Cyders et al., 2007), it is also likely that binge drinking college students high on positive urgency will experience stronger alcohol cravings following cue exposure.

Taken together, individuals high on urgency might experience greater alcohol cravings due to this enhanced reactivity (Pavlick, 2007). Among these individuals, alcohol cravings might reflect a desire to address emotional needs (Cyders et al., 2009; Doran et al., 2009; Settles et al., 2010). In turn, due to their tendency to focus on emotional needs when faced with strong emotions, these individuals might be at increased risk for problematic drinking because they would have a harder time resisting their cravings (Cyders et al., 2007; Smith et al., 2007). In this way, both high levels of

urgency and cue reactivity might strengthen the effect of alcohol cravings on problematic drinking. The third aim of the present study was to examine the interactive effects of cue reactivity, alcohol cravings, and urgency on problematic alcohol use. I hypothesized that alcohol cravings will be more strongly associated with problematic drinking among individuals high on both urgency and cue reactivity.

Aims of the Study

The overall aim of the present study was to elucidate the mechanisms that underlie college student problematic drinking. In particular, the present study examined the interactive effects of alcohol cravings, alcohol cue reactivity, and urgency on problematic alcohol use among college students. The specific aims of the proposed study were to examine the (1) interaction between alcohol cravings and urgency, (2) interaction between cue reactivity and alcohol cravings, and (3) interactive effects among cue reactivity, urgency, and alcohol cravings on college students' problematic alcohol use. I hypothesized that alcohol cravings will be most strongly associated with problematic drinking at higher levels of (1) urgency, (2) cue reactivity, and (3) cue reactivity and urgency.

METHOD

Participants and Data Restrictions

Participants were recruited from the Human Research Participant Pool (HRPP) at IUPUI, which consists of students who are enrolled in lower division psychology courses. Study data were obtained from an initial sample of undergraduate students ($n = 457$). Participants had to be at least 18 years old and fluent in English, and must have consumed alcohol in the past month in order to be eligible for the study. During the study, participants were also exposed to alcohol and non-alcohol pictures and were asked questions about those pictures. Participants who did not meet the inclusion criteria and participants who answered incorrectly to four or more questions were excluded from the dataset (26 participants excluded; $n = 431$). When I ran analyses using this sample, I found non-significant results.

One possible reason for the non-significant results is that the college student sample is not representative of regular college students. In particular, the IUPUI student body consisted of several non-college age students. In contrast, students who are between 18 and 25 might be more representative of regular college students. As such, in order to focus on young adults as recommended by NIAAA (Chen, Dufour, & Yi, 2005), the study sample was restricted to ages 18-25 (49 participants excluded; $n = 382$). Another possible reason for the null results is that the sample consisted mostly of less experienced

college drinkers, who have lower levels of cue reactivity and alcohol cravings. As such, in order to sample individuals who are more regular drinkers, the final study sample was also restricted to those who drank more than once in the past month, (142 participants excluded; $n = 240$). After imposing restrictions on the data set, I found more significant results. However, results that were obtained from the final sample might only apply to young college students who are regular drinkers. Moreover, these restrictions might have also reduced the robustness of my obtained results and might increase the likelihood that my results are due to chance (Type I error).

Approximately 75% of the final sample was Caucasian and 10.8% was African American, with the remaining 14.2% comprising other races. Approximately 30% of the students were males and 70% were females. Mean age was 19.37 ($SD = 1.65$). I examined whether demographic variables and key study variables would be significantly different between participants who were included in the final sample and participants who were excluded from the final sample. I first examined differences in categorical variables using chi-square test of independence. Gender distribution did not significantly differ between excluded and included participants, $\chi^2(1, N = 449) = 0.003, p = 0.96$. However, race distribution did significantly differ between excluded and included participants, $\chi^2(5, N = 452) = 14.68, p = 0.01$. I then examined differences in continuous variables using independent samples t-test. Excluded participants were significantly older compared to included participants ($p < 0.05$). However, included participants were significantly higher on problematic drinking, alcohol cravings, cue reactivity, positive urgency, and negative urgency compared to excluded participants (all $p < 0.05$). Tables A1 and A2 (see Appendix A) summarize these results.

Measures and Materials

Urgency

Negative and positive urgency were assessed using the UPPS-P Impulsive Behavior Scale—which is a 59-item inventory designed to measure personality dispositions to impulsive behaviors (UPPS-P; Lynam, Smith, Cyders, Fischer, & Whiteside, 2007). The negative urgency subscale consists of 12 items ($\alpha = 0.87$), which assess the tendency to behave impulsively in face of strong negative emotions. The positive urgency subscale consists of 14 items ($\alpha = 0.92$), which assess the tendency to behave impulsively in face of strong positive emotions. These items were assessed in terms of endorsement level, with response options ranging from (0) “Strongly disagree” to (3) “Strongly agree.” Positive urgency items and negative urgency items were calculated as separate means—with a higher mean value indicating a higher level of urgency. Participants had an average of 0.94 ($SD = 0.55$) for positive urgency and 1.37 ($SD = 0.56$) for negative urgency. Mean values are typical for a college student sample. Cyders et al. (2007) found that mean values for positive urgency ranged from 2.21 to 2.28 ($SD = 0.50$ to 0.61) and that mean values for negative urgency ranged from 1.58 to 1.86 ($SD = 0.57$ to 0.66) across multiple college student samples. However, in that study, urgency items had response option values that ranged from 1 to 4 instead of 0 to 3. When using the 1 to 4 response option values, the present study found a mean value of 2.37 ($SD = 0.56$) for negative urgency and a mean value of 1.94 ($SD = 0.55$) for positive urgency.

Problematic Alcohol Use

Problematic alcohol use was assessed using the Alcohol Use Disorder Identification Test (AUDIT; Babor, de la Fuente, Saunders, & Grant, 1992). Prior studies have indicated that the AUDIT was able to identify problematic drinkers among medical patients (Bohn, Babor, & Kranzler, 1995) and among college students (Fleming, Barry, & Macdonald, 1991). Furthermore, among alcohol dependent individuals, AUDIT score was associated with greater severity in symptoms of alcohol dependence (Donovan, Kivlahan, Doyle, Longabaugh, & Greenfield, 2006). Finally, reviews of the AUDIT have provided support for its reliability and validity (Allen, Litten, Fertig & Babor, 1997; Reinert & Allen, 2002). The AUDIT consists of 10 items ($\alpha = 0.75$), which assess problematic patterns of alcohol use. All items were rated on a 5-point Likert scale, with higher ratings indicating higher levels of alcohol involvement. This scale was calculated as a summed value. Scores on the AUDIT can range from 0 to 50, with higher summed values indicating greater levels of problematic alcohol use.

Participants reported a mean value of 8.43 ($SD = 4.19$) for problematic alcohol use. Based on the AUDIT manual, AUDIT scores in the range of 8 to 15 represented a medium level of problematic drinking, whereas scores of 16 and above represented a high level of problematic drinking (Babor et al., 1992). Furthermore, scores between 8 and 15 suggest a need for simple advice focused on reducing hazardous drinking, scores between 16 and 19 suggest a need for brief counseling and continued monitoring, and scores greater than 20 warrant further diagnostic evaluation for alcohol dependence (Babor et al., 1992). Based on these scores, the average participants in the sample have a low to

medium level of problematic drinking and might not require much intervention for their alcohol use behaviors.

Alcohol Cravings and Cue Reactivity

Alcohol cravings were measured using the Obsessive Compulsive Drinking Scale (OCDS; Anton et al., 1995). The OCDS was developed as a measure of alcohol cravings (Anton, 2002). Furthermore, prior studies have also used the OCDS as a measure of alcohol cravings (Flannery, Poole, Gallop, & Volpicelli, 2003; Kranzler, Mulgrew, Modesto-Lowe, & Burtleson, 1999). The OCDS consists of 14 items ($\alpha = 0.80$), which assess a participant's thoughts about drinking and compulsive drinking behaviors. Items of the OCDS are anchored on a scale from 0 to 4, on which higher scores indicate increased trait alcohol cravings. The OCDS was calculated as a mean value, with higher values indicating greater levels of alcohol cravings. Participants reported a mean value of 0.51 ($SD = 0.37$) for alcohol cravings. This OCDS score is most commonly seen among social drinkers, who generally report low levels of alcohol cravings, rather than problematic drinkers (Anton, 2000).

Cue reactivity was measured using the Alcohol Urge Questionnaire (AUQ; Bohn et al., 1995). The AUQ consists of 8 items, which assess a participant's urge for an alcoholic drink at the time the questionnaire is completed. All items of the AUQ were scored along a 7-point Likert scale, with response options ranging from (0) "Strongly disagree" to (6) "Strongly agree." The AUQ was calculated as a summed value, with higher values indicating greater levels of cue reactivity. Internal consistency coefficient was 0.80 for neutral cue induced alcohol cravings and 0.84 for alcohol cue induced

alcohol cravings. Participants reported a mean value of 8.66 ($SD = 8.85$) for alcohol cue induced alcohol cravings and 7.63 ($SD = 8.07$) for neutral cue induced alcohol cravings.

Pictorial Cues and Assessment

Each participant was presented with two picture sets— an alcohol picture set and a non-alcohol picture set. Each set of pictures consisted of five color photographs. These pictures were matched for content across the two picture sets. All pictures were taken from prior studies using dot probe tasks (Field & Eastwood, 2005). The alcohol pictures from these studies have been shown to increase alcohol cravings (Field & Eastwood, 2005; Field et al., 2007; Field, Mogg, Zetteler, & Bradley, 2004). All pictures were 7.00 inches high and 5.06 inches wide. Following exposure to each picture set, participants also completed eight questions about the content of the pictures.

Procedure

After enrolling in a web-based participant registry, students gained access to information about the present study on IUPUI's Human Research Participant Pool (HRPP) website. Participants were informed that they can earn 2 research credits toward their introductory psychology course for completion of the study, and that the study will ask questions about their personality and alcohol use behaviors. Potential participants were also presented with an initial survey that determined if they could participate in the study. Eligible participants were instructed to go to one of the classrooms on campus in order to complete the survey online. Potential participants were presented with a set of times for completing the study and were prompted to select one of the times.

In the classroom, participations were presented with an informed consent form. This consent form included some information regarding the background and purpose of the study, possible risks involved, and confidentiality. After signing the consent form, students were presented with the web-based survey on a computer. On this survey, participants first completed the Obsessive Compulsive Drinking scale, Urgency subscales of the UPPS Impulsive Behavior Scale, and the Alcohol Use Disorder Identification Test. Following completion of these questionnaires, participants were exposed to pictorial cues. Each participant was presented with two picture sets— an alcohol picture set and a non-alcohol picture set. After viewing each picture set, participants answered eight questions about the content of the pictures. Following that, participants completed the Alcohol Urge Questionnaire. At the end of the survey, participants were presented with a debriefing form on the web survey for more information about the study and were provided with counseling service contact information, should they be concerned about their answers or their alcohol use behaviors.

Analytic Strategy

All analyses were conducted using SPSS 19.0. I first examined whether data from key variables are missing at random. Only positive urgency (.4 to .8% missing per item), negative urgency (.4 to .8% missing per item), and non-alcohol cue reactivity (.8 to 1.3% missing per item) were missing data at random. Data for these variables were imputed using expectation maximization. Results did not differ between imputed and non-imputed data sets. Second, I examined normality of all predictors and outcomes. Using an absolute value of less than 3.0 for skewness and less than 10.0 for kurtosis (Kline, 1998), no

variables met the criteria for non-normal distribution. Third, using bivariate correlations, I examined the relationships among predictors and outcome. Fourth, using t-tests, I examined the differences in (1) cue reactivity between alcohol cues and non-alcohol cues, and (2) problematic drinking between men and women. Fifth, using simultaneous multiple regression analyses, I examined whether urgency predicted cue reactivity over and above alcohol cravings.

Finally, hierarchical multiple regression was used to examine interactions. All continuous predictors were centered to facilitate interpretation of the interaction coefficients, and simple slope analyses (Cohen, Cohen, West, & Aiken, 2003) and slope difference tests (Dawson & Richter, 2006) were used to interpret significant interactions. Because problematic alcohol use has been shown to differ by gender, age, and race (Jackson, William, & Gomberg, 1998; Leigh & Stacy, 2004; Steinman, Ferketich, & Sahr, 2006; Nolen-Hoeksema, 2004), these variables were included as covariates. For all interaction analyses, covariates were entered in the first step and individual predictors in the second step. For two-way interaction analyses, interaction terms were entered in the third step. For three way interaction analyses, two-way interaction terms were entered in the third step and three-way interaction terms in the fourth step. The interaction between cue reactivity and urgency was included in the third step of the three way interaction analyses. Because negative and positive urgency are strongly correlated, I ran separate hierarchical multiple regression analyses for the urgency facets.

RESULTS

Initial Analyses

Negative urgency was strongly and positively correlated with positive urgency ($r = 0.67, p < 0.0001$), was moderately and positively correlated with problematic drinking ($r = 0.39, p < 0.001$) and alcohol cravings ($r = 0.44, p < 0.001$), and was weakly and positively correlated with cue reactivity ($r = 0.28, p < 0.001$). Positive urgency was moderately and positively correlated with problematic drinking ($r = 0.47, p < 0.0001$), alcohol cravings ($r = 0.47, p < 0.001$), and cue reactivity ($r = 0.32, p < 0.001$). Problematic drinking was strongly and positively correlated with alcohol cravings ($r = 0.57, p < 0.001$), but was weakly and positively correlated with cue reactivity ($r = 0.30, p < 0.001$). Finally, alcohol cravings were moderately and positively correlated with cue reactivity ($r = 0.46, p < 0.001$). Table B1 (see Appendix B) summarizes these results.

Using dependent samples t-tests, cue reactivity significantly differed between alcohol pictures ($M = 8.66, SD = 8.85$) and non-alcohol pictures ($M = 7.63, SD = 8.07$), $t(239) = 6.05, p < 0.0001$. Furthermore, using independent samples t-test, men and women did not significantly differ on problematic drinking, $t(237) = 1.79, p = 0.08$. However, this difference did fall short of significance, with a trend toward men reporting higher levels of problematic drinking ($M = 9.22, SD = 4.41$) compared to women ($M = 8.16, SD = 4.05$). Finally, using simultaneous multiple regression, positive urgency had a

significant effect on cue reactivity ($b = 2.06, p = 0.049$), over and above alcohol cravings. However, negative urgency did not have a significant effect on cue reactivity ($b = 1.53, p = 0.09$), over and above alcohol cravings. Table B2 summarizes t-test results and Table B3 summarizes the simultaneous regression results (see Appendix B).

Interaction Analyses

To examine the first hypothesis, I tested whether the urgency facets moderated the effects of alcohol cravings on problematic drinking (see Appendix C, Table C1). Results indicated that the interaction between positive urgency and alcohol cravings was non-significant ($b = -0.75, p = 0.45$). However, the interaction between negative urgency and alcohol cravings was significant ($b = -2.28, p = 0.03$). Using simple slope analyses, alcohol cravings were associated with problematic drinking at low levels of negative urgency ($b = 7.36, p < 0.001$), but this effect weakened at mean ($b = 6.09, p < 0.001$) and high ($b = 4.82, p < 0.001$) levels of negative urgency, although the effect remained significant at all levels (see Appendix D, Figure D1). Using slope difference tests, the slopes for alcohol cravings significantly differed at high negative urgency and low negative urgency. To examine the second hypothesis, I tested whether cue reactivity moderated the effects of alcohol cravings on problematic drinking (see Appendix C, Table C2). Results indicated that the interaction between cue reactivity and alcohol cravings was non-significant ($b = -0.61, p = 0.32$).

Finally, to examine the final hypothesis, we tested whether there would be three-way interactions among cue reactivity, alcohol cravings, and urgency on problematic drinking. There was a significant three-way interaction involving negative urgency ($b = -$

0.21, $p = 0.04$) (see Appendix C, Table C3). The effect of alcohol cravings on problematic drinking was significant at low negative urgency and cue reactivity ($b = 5.34, p = 0.001$), low negative urgency and high cue reactivity ($b = 8.69, p < 0.001$), high negative urgency and low cue reactivity ($b = 5.53, p < 0.0001$), and high negative urgency and cue reactivity ($b = 4.71, p < 0.001$). Alcohol cravings seem to be most strongly associated with problematic drinking at low negative urgency and high cue reactivity. Using slope difference tests, slope 1 (high negative urgency and cue reactivity) and slope 3 (low negative urgency and high cue reactivity) are significantly different, with slope 3 having a steeper curve (see Appendix D, Figure D2).

The interaction among positive urgency, cue reactivity, and alcohol cravings on problematic drinking falls short of significance ($b = -0.16, p = 0.08$) (see Appendix C, Table C3). Once again, the effect of alcohol cravings on problematic drinking was significant at all levels of the moderator. Alcohol cravings were associated with problematic drinking at low positive urgency and cue reactivity ($b = 4.51, p = 0.005$), low positive urgency and high cue reactivity ($b = 5.90, p < 0.001$), low cue reactivity and high positive urgency ($b = 6.56, p < 0.001$), and high cue reactivity and high positive urgency ($b = 4.90, p < 0.001$). Alcohol cravings seem to be most strongly associated with problematic drinking at low cue reactivity and high positive urgency. However, using slope difference tests, there were no significant slope differences (see Appendix D, Figure D3).

DISCUSSION

General Discussion

I hypothesized that alcohol cravings would be most strongly associated with problematic drinking at higher levels of urgency, higher levels of cue reactivity, and higher levels of both urgency and cue reactivity. However, my results were inconsistent with these hypotheses. Results of the present study indicated that alcohol cravings were more strongly associated with problematic drinking at low levels of negative urgency, high levels of cue reactivity and low levels of negative urgency, and high levels of positive urgency and low levels of cue reactivity. In the past, the alcohol cravings-problematic drinking associations have been highly inconsistent (Cooney et al., 1997; Drummond & Glautier, 1994; Miller et al., 1996). Although inconsistent with my hypotheses, my findings suggest that inconsistencies in prior studies might be related to differing levels of urgency and cue reactivity in different samples. Furthermore, although limitations in the present study limit the inferences we can draw about implications of these results, these results can still help us better understand the risk of problematic drinking among college students. In particular, if these findings were to be replicated and clarified in future studies, urgency and cue reactivity might become important factors to consider in better determining how alcohol cravings can create risk for college student problematic drinking.

Interaction between Urgency and Alcohol Cravings

I hypothesized that alcohol cravings would be associated with increased problematic drinking at higher levels of urgency. Contrary to my hypothesis, my results indicated that alcohol cravings did not interact with positive urgency and were most strongly associated with problematic drinking at lower levels of negative urgency. Findings of the present study clarify the inconsistent alcohol cravings-problematic drinking association (Cooney et al., 1997; Drummond & Glautier, 1994; Miller et al., 1996) by emphasizing the importance of contexts in understanding how alcohol cravings create risk for problematic drinking. Specifically, these findings suggest that alcohol cravings might create greater risk of problematic drinking among individuals low on urgency and might be a risk factor for problematic drinking that is independent of positive urgency.

It is possible that alcohol cravings are exerting weaker effects on problematic drinking among individuals high on negative urgency because they are already reporting higher levels of problematic drinking. Specifically, individuals high on negative urgency have been shown to be at higher risk for problematic drinking (Cyders et al., 2007; Cyders et al., 2009). Due to their already heightened risk, the experience of alcohol cravings might not add significantly more to their risk for problematic drinking. In contrast, individuals low on negative urgency might have lower risk for problematic drinking. In turn, alcohol cravings might create greater risk among these individuals because they are not already at heightened risk for problematic drinking. Future experimental studies should examine whether the induction of alcohol cravings would

differentially affect alcohol consumption rate among individuals at different levels of urgency.

At the same time, prior studies have indicated that the experience of strong emotions among individuals high on urgency might produce higher alcohol cravings, which might be reflective of their desire to alleviate negative affect or enhance positive affect (Billieux, Van der Linden, & Geschi, 2007; Doran et al., 2009; Pavlick, 2007). Moreover, prior studies have also suggested that individuals high on urgency might be at risk for problematic drinking because they would have a harder time resisting these cravings (Cyders et al., 2007; Smith et al., 2007). However, these studies did not directly examine whether alcohol cravings would play an important role in driving problematic drinking among individuals high on urgency. Findings of the present study clarify that problematic drinking among individuals high on urgency might not be strongly driven by the experience of alcohol cravings.

Specifically, although strong emotions might drive problematic drinking among individuals high on urgency (Cyders et al., 2007; Smith et al., 2007), these strong emotions do not necessarily drive problematic drinking by eliciting increased alcohol cravings. When faced with strong positive emotions, individuals high on positive urgency might be more likely to engage in problematic drinking, but not because they have elevated alcohol cravings. Similarly, individuals high on negative urgency might also engage in problematic drinking in response to strong negative emotions, but not because they have elevated alcohol cravings. Other factors, such as expectations that drinking will immediately address emotional states (Fischer, Smith, Anderson, & Flory, 2003), may play more salient roles in driving problematic drinking when individuals high on urgency

are faced with strong emotions. Future studies should examine whether urgency might interact with these other factors to influence problematic drinking.

Interaction between Cue Reactivity and Alcohol Cravings

I hypothesized that alcohol cravings would be more strongly associated with problematic drinking among college students who are higher on cue reactivity. Contrary to this hypothesis, my results indicated that alcohol cravings did not interact with cue reactivity on problematic drinking. These results suggest that cue reactivity does not play a substantial role in the alcohol cravings-problematic drinking association among college students. It is possible that cue reactivity and alcohol cravings are independent risk factors for problematic drinking. Although cue reactivity and alcohol cravings have been shown to influence alcohol use (Drobes & Thomas, 1999), their effects on problematic drinking might be additive rather than synergistic.

At the same time, results of the present study are inconsistent with prior findings. Among problematic drinkers, greater cue reactivity has been shown to produce greater alcohol cravings (Kareken et al., 2004; Pomerleau et al., 1983). These findings suggest that both alcohol cravings and cue reactivity may play important roles in maintaining and driving problematic drinking. However, these studies used a sample of problematic drinkers. In contrast, my study used a sample of college students who are regular drinkers rather than problematic drinkers. As such, although cue reactivity and alcohol cravings may play important roles in driving problematic drinking among problematic drinkers, their roles in driving problematic drinking among regular college drinkers may be less

substantial. Future studies should examine whether the cue reactivity-alcohol cravings interaction might be present among problematic college drinkers.

Relatedly, prior studies suggest that problematic drinkers have greater alcohol cravings and greater risk for problematic drinking because they have acquired enhanced reactivity to alcohol cues (Kareken et al., 2004; Pomerleau et al., 1983). These problematic drinkers may have acquired enhanced cue reactivity because they are more experienced drinkers (Siegel, 1983; Wikler, 1973; Field et al., 2005). In contrast, the college participants of the present study might have less drinking experiences, and might not have developed the same level of cue reactivity that could increase alcohol cravings and consequent alcohol use. My findings, along with findings of prior studies, suggest that enhanced cue reactivity might be producing increased alcohol cravings and increased risk for problematic drinking among more experienced problematic drinkers but not among less experienced college drinkers.

Three-Way Interactions

I hypothesized that alcohol cravings would be more strongly associated with problematic drinking among individuals high on both urgency and cue reactivity. Although inconsistent with my hypothesis, findings of the present study clarify the inconsistent alcohol cravings-problematic drinking association in prior studies (Cooney et al., 1997; Drummond & Glautier, 1994; Miller et al., 1996). My findings suggest that alcohol cravings might be a more consistent and salient risk factor for problematic drinking among college students who are reporting specific levels of cue reactivity and urgency. More specifically, my findings indicated that alcohol cravings confer greater

risk for problematic drinking among college students with higher levels of cue reactivity and lower levels of negative urgency, and among college students with lower levels of cue reactivity and higher levels of positive urgency.

Individuals high on urgency are already at higher risk for problematic drinking (Cyders et al., 2007; Cyders et al., 2009). As a result, alcohol cravings and/or cue reactivity might not be adding substantially more to their risk of problematic drinking. In particular, because individuals high on positive urgency already have heightened risk for problematic drinking, cue reactivity might not be adding substantially more to their risk of problematic drinking. In contrast, alcohol cravings and cue reactivity might create greater risk among individuals low on urgency because they are not already at heightened risk for problematic drinking. In particular, because individuals low on negative urgency are at lower risk for problematic drinking, cue reactivity and alcohol cravings can confer greater risk for problematic drinking. Future experimental studies should examine whether the induction of alcohol cravings and cue reactivity would differentially affect alcohol consumption rate among individuals at different levels of urgency.

At the same time, prior studies have suggested that individuals high on urgency might be more likely to develop cue reactivity because they have higher rates of drinking (Pavlick, 2007; Settles et al., 2010). Among these individuals, enhanced reactivity to alcohol cues might increase alcohol cravings, which might be specifically reflective of their desire to address emotional states (Billieux et al., 2007; Doran et al., 2009; Pavlick, 2007). In turn, individuals high on urgency might be at risk for problematic drinking because they would have a harder time resisting these cravings (Cyders et al., 2007; Smith et al., 2007). However, these studies did not directly examine whether alcohol

cravings and cue reactivity are drivers of problematic drinking among individuals high on urgency. In turn, findings of the presents study clarify that problematic drinking among individuals high on urgency are not driven by elevations in cue reactivity and alcohol cravings.

Although higher rates of drinking might facilitate alcohol specific learning processes among individuals high on urgency (Settles et al., 2010), these findings suggest that higher rates of drinking among these individuals might not lead to enhanced cue reactivity and to increased alcohol cravings. Relatedly, although both cue reactivity and alcohol cravings can be thought as drivers of problematic drinking among individuals high on urgency (Cyders et al., 2007; Smith et al., 2007; Pavlick, 2007), my findings clarify that problematic drinking among these individuals might not be driven by heightened levels of alcohol cravings and cue reactivity. Other factors, such as increased reward salience associated with alcohol use (Cyders, Dzemidzic, Eiler, Coskunpinar, Karyadi, & Kareken, under review), might play more important roles in driving problematic drinking among individuals high on urgency. Future studies should examine other factors that might drive problematic drinking among individuals high on urgency.

Methodological, Sample, and Data Limitations

My results could also be partly explained by methodological limitations in my study, and by limitations in my sample and in my data set. First, the present study did not utilize mood induction—which has been shown to increase cue reactivity, alcohol cravings, and the risk of problematic drinking (Cooney et al., 1997; Rubonis et al., 1994). Among individuals high on urgency, it is possible that alcohol cravings, enhanced cue

reactivity, and problematic drinking might only manifest when strong emotional states are present. Future experimental studies should examine whether emotionally induced alcohol cravings and cue reactivity might increase alcohol use among individuals high on urgency. Second, among individuals high on urgency, alcohol cravings might reflect a desire to address emotional needs through alcohol use (Cyders et al., 2007; Doran et al., 2009). Unfortunately, the present study did not specifically examine emotionally driven alcohol cravings. Future studies should examine whether cue reactive individuals high on urgency might have greater emotionally driven cravings that increase their risk for problematic drinking.

Fourth, higher rates of drinking among individuals high on urgency might lead to the development of more specific forms of cue reactivity. In particular, there are other forms of cue reactivity that might be more likely to increase alcohol cravings and problematic drinking. For instance, attentional biases for alcohol cues produced alcohol cravings (Field et al., 2004), which in turn increased alcohol consumption (Field & Eastwood, 2005). Similarly, exposure to alcohol cues among alcoholics increased salivation and alcohol cravings (Monti et al., 1993), both of which predicted increased frequency of drinking days (Rohsenow et al., 1994). Among individuals high on urgency, it is possible that alcohol cravings might be more consistently predictive of problematic drinking when these other forms of cue reactivity are present. Future studies should examine whether urgency and alcohol cravings might interact with different forms of cue reactivity to influence problematic drinking.

Fifth, it is possible that alcohol pictorial cues did not successfully elicit reactivity to alcohol cues. This might be because the alcohol and non-alcohol pictorial cues were too

closely matched, resulting in the small difference in cue reactivity between alcohol pictures and non-alcohol pictures. Future studies should examine whether other alcohol cues (e.g. smell or taste of alcohol) might be more successful in eliciting higher levels of cue reactivity, and whether this heightened level of cue reactivity might significantly interact with alcohol cravings and urgency to influence problematic drinking. Relatedly, it is also possible that my measure of cue reactivity failed to tap into pictorial cue induced cue reactivity. This is possible considering that the Alcohol Urge Questionnaire was specifically developed as a measure of state alcohol cravings (Bohn et al., 1995) rather than cue reactivity. Future studies should examine whether pictorial cues would produce different levels of cue reactivity among different measures of cue reactivity, and whether cue reactivity from different measurements might interact differently with alcohol cravings and urgency to influence problematic drinking.

Sixth, levels of alcohol cravings, cue reactivity, and problematic drinking are low in the current sample. Indeed, the average participants in the sample have a level of problematic drinking that is lower than highly problematic drinkers and might not require much intervention for alcohol use (Babor et al., 1992), reported cue reactivity levels that are much lower compared to problematic drinkers (Johnson, Cloninger, Roache, Bordnick, & Ruiz, 19998; MacKillop, 2006), and exhibited low levels of alcohol cravings that are most commonly reported among social drinkers rather than problematic drinkers (Anton, 2000). In the sample, there might be few participants high on urgency who are reporting high levels of cue reactivity, alcohol cravings, and problematic drinking. Future studies should replicate the present study's interaction results using a sample of clinical or problematic drinkers who have high levels of cue reactivity and alcohol cravings.

Finally, I have also imposed a number of restrictions on my data set. This might increase the likelihood that my results are due to chance and that my results are not robust to replication. In particular, these restrictions may have produced unusual interactions that are not actually present in nature. Future studies should attempt to replicate my interaction results.

General Study Limitations

The present study has some limitations, which might hamper its generalizability. First, the study used a convenient college student sample from the psychology participant pool at IUPUI, which consisted mostly of Caucasian and female undergraduate students. As such, results from this sample might not be generalizable to other populations with different demographic characteristics. Furthermore, even though both gender and ethnicity were controlled in interaction analyses, imbalances in the sample might have an impact on the results. For instance, considering the higher rates of drinking among men (Nolen-Hoeksema, 2004) and Caucasians (Caetano, 1984), gender and ethnicity imbalances in the current sample might be attenuating the effects of some the predictors on problematic drinking. Second, although there were some manipulations in the study, the present study is still cross-sectional in nature. As such, causal inferences should not be drawn from the results. Third, although participants completed the study in a controlled classroom environment, data for the present study were collected through self-report measures. As a result, participants' responses to these measures might have been susceptible to response biases (Arnold & Feldman, 1981). Finally, I have also imposed a number of restrictions on the data set. Due to these restrictions, results from the present

study might be generalizable only to young college students who are more regular drinkers. Moreover, due to these restrictions, there is a higher likelihood that my results are due to chance and that my results might not be robust. If this is the case, future studies might not be able to replicate the findings from the present study.

The present study also has some limitations regarding measurements. For instance, based on the average AUDIT score, participants in the study are not considered highly problematic drinkers (Babor et al., 1992). In turn, this low rate of problematic drinking in the sample might have affected the results. This emphasizes the need to utilize more clinical samples, particularly those who have higher levels of problematic drinking. Furthermore, the sample on average exhibited low levels of cue reactivity and alcohol cravings, which might have an influence on the results. In particular, these low levels indicate that there might be very few participants high on both cue reactivity and alcohol cravings who are engaging in problematic levels of alcohol use. This might potentially explain some of my null results. Finally, cue reactivity was induced using pictorial cues and measured as increased state alcohol cravings. Other forms of inducing and measuring cue reactivity might yield different results. For instance, the alcohol cravings-cue reactivity interaction might be significant if cue reactivity were to be measured as attentional biases and induced using other alcohol-related stimuli (e.g. smell and taste).

Future Directions

At the same time, limitations of the present study can better inform us about how to better test the present study's hypotheses. First, considering that the sample is mostly

comprised of Caucasian students and female students, future studies should utilize stratified random sampling in order to obtain a more balanced sample. This will make the results of the study more generalizable to other populations with different demographic characteristics. Furthermore, considering that most problematic drinkers are men (Nolen-Hoeksema, 2004), having a sample that is mostly comprised of women might have lowered the level of problematic drinking in the current study. This gender imbalance might be one factor that is partly causing the restriction of range in problematic drinking in the present study. In turn, a more balanced sample (e.g. 50% men and 50% women) might yield a different level of problematic drinking. Second, because causal inferences cannot be drawn due to the cross-sectional nature of the present study, future studies should utilize experimental methods in order to draw causal inferences. For instance, using a sample of individuals high on urgency, future studies can examine whether exposure to alcohol cues (e.g. sight, taste, and smell of alcohol) can produce increased cue reactivity, alcohol cravings, and alcohol consumption. Third, because participants' responses on self-report measures might be susceptible to response biases, future studies can utilize more objective measures. For instance, cue reactivity can be measured as attentional biases as opposed to self-reported alcohol cravings and problematic drinking can be measured as alcohol consumption rate rather than self-reported past alcohol consumption. Fourth, levels of alcohol cravings, problematic drinking, and cue reactivity are generally low in the current sample. Because these low levels might have affected the results, future studies should utilize more stringent recruitment criteria. For instance, future studies can use screening measures in order to obtain a sample of problematic drinking college students who are high on both cue reactivity and alcohol cravings. Fifth,

considering that other forms of inducing and measuring cue reactivity might yield different results, future studies should compare different ways of measuring and inducing cue reactivity. For instance, future studies should compare whether cue induced attentional biases and salivation might interact differently with alcohol cravings and urgency to influence alcohol consumption.

Conclusions

The present study examined the interactive effects of cue reactivity, alcohol cravings, and urgency on problematic alcohol use. Results indicated that alcohol cravings were most strongly associated with problematic drinking at lower levels of negative urgency, higher levels of cue reactivity and lower levels of negative urgency, and lower levels of cue reactivity and higher levels of positive urgency. Overall, these findings help explain prior inconsistencies in the literature by emphasizing the importance of considering the roles of urgency and cue reactivity in understanding how alcohol cravings create risk for problematic drinking. Furthermore, these findings suggest the need to consider a combination of these three factors when addressing problematic drinking among college students. In addition, although results are inconsistent with my hypotheses, the present study still demonstrates the feasibility of testing three-way interactions using a cross-sectional approach. Finally, the present study provided preliminary results that could guide future studies. Based on these results, future studies can consider using different measures and methodologies to elucidate the relationships among cue reactivity, urgency, alcohol cravings, and problematic drinking.

REFERENCES

REFERENCES

- Anton, R. F. (2000). Obsessive-compulsive aspects of craving: Development of the Obsessive Compulsive Drinking Scale. *Addiction, 95*, S211-S217.
- Anton, R. F., Moak, D. H., & Latham, P. (1995). The obsessive compulsive drinking scale: A self-rated instrument for the quantification of thoughts about alcohol and drinking behavior. *Alcoholism: Clinical and Experimental Research, 19*, 92-99.
- Arnold, H. J., & Feldman, D. C. (1981). Social desirability response bias in self-report choice situations. *Academy of Management Journal, 24*, 377-385.
- Babor, T. F., de la Fuente, J. R., Saunders, J., & Grant, M. (1992). *The alcohol use disorders identification test: Guidelines for use in primary health care*. Geneva, Switzerland: World Health Organization.
- Billieux, J., Van der Linden, M., & Geschi, G. (2007). Which dimensions of impulsivity are related to cigarette craving? *Addictive Behaviors, 32*, 1189-1199.
- Blanco, C., Okuda, M., Wright, C., Hasin, D. S., Grant, B. F., Liu, S., & Olfson, M. (2008). *Archives in General Psychiatry, 65*, 1429-1446.
- Bohn, M. J., Krahn, D. D., & Staehler, B. A. (1995). Development and initial validation of a measure of drinking urges in abstinent alcoholics. *Alcoholism: Clinical and Experimental Research, 19*, 600-606.

- Caetano, R. (1984). Ethnicity and drinking in northern California: A comparison among whites, blacks, and Hispanics. *Alcohol and Alcoholism, 19*, 31-44.
- Carter, B. L., & Tiffany, S. T. (1999). Meta-analysis of cue-reactivity in addiction research. *Addiction, 94*, 327-340.
- Chen, C. M., Dufour, M. C., & Yi, H. (2005). Alcohol consumption among young adults ages 18-24 in the United States: Results from the 2001-2002 NESARC survey. *Alcohol Research & Health, 28*, 269-280.
- Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences* (3rd ed.). Mahwah, NJ: Erlbaum.
- Cooney, N. L., Litt, M. D., Morse, P. A., Bauer, L. O., & Gaupp, L. (1997). Alcohol cue reactivity, negative-mood reactivity, and relapse in treated alcoholic men. *Journal of Abnormal Psychology, 106*, 243-250.
- Cooper, M. L., Frone, M. R., Russell, M., & Mudar, P. (1995). Drinking to regulate positive and negative emotions: A motivational model of alcohol use. *Journal of Personality and Social Psychology, 69*, 990-1005.
- Cyders, M. A., & Coskunpinar, A. (2010). Is urgency emotionality? Separating urgent behaviors from effects of emotional experiences. *Personality and Individual Differences, 48*, 839-844.
- Cyders, M. A., Dzemidzic, M., Eiler, W. J., Coskunpinar, A., Karyadi, K. A., & Kareken, D. A. (under review). Negative urgency and ventromedial prefrontal cortex responses to alcohol cues: fMRI evidence of emotion-based impulsivity.

- Cyders, M. A., Flory, K., Rainer, S., & Smith, G. T. (2009). The role of personality dispositions to risky behavior in predicting first-year college drinking. *Addiction, 104*, 193-202.
- Cyders, M. A., & Smith, G. T. (2008). Emotion-based dispositions to rash action: Positive and negative urgency. *Psychological Bulletin, 134*, 807-828.
- Cyders, M. A., Smith, G. T., Spillane, N. S., Fischer, S., Annus, A. M., & Peterson, C. (2007). Integration of impulsivity and positive mood to predict risky behavior: Development and validation of a measure of positive urgency. *Psychological Assessment, 19*, 107-118.
- Cyders, M. A., Zapolski, T. C. B., Combs, J. L., Settles, R. F., Fillmore, M. T., & Smith, G. T. (2010). Experimental effects of positive urgency on negative outcomes from risk taking and on increased alcohol consumption. *Psychology of Addictive Behaviors, 24*, 367-375.
- Dawson, J. F., & Richter, A. W. (2006). Probing three-way interactions in moderated multiple regression: Development and application of a slope difference tests. *Journal of Applied Psychology, 91*, 917-926.
- Davidson, D., Palfai, T., Bird, C., & Swift, R. (1999). Effects of naltrexone on alcohol self-administration in heavy drinkers. *Alcoholism: Clinical and Experimental Research, 23*, 195-203.
- Doran, N., Cook, J., McChargue, D., & Spring, B. (2009). Impulsivity and cigarette craving: Differences across subtypes. *Psychopharmacology, 207*, 365-373.

- Doran, N., Spring, B., & McChargue, D. (2007). Effect of impulsivity on craving and behavioral reactivity to smoking cues. *Psychopharmacology, 194*, 279-288.
- Drobes, D. J., & Thomas, S. E. (1999). Assessing craving for alcohol. *Alcohol Research and Health, 23*, 179-186.
- Drummond, D. C., & Glautier, S. A. (1994). A controlled trial of cue exposure treatment in alcohol dependence. *Journal of Consulting and Clinical Psychology, 62*, 809-817.
- Field, M., & Eastwood, B. (2005). Experimental manipulation of attentional bias increases the motivation to drink alcohol. *Psychopharmacology, 183*, 350-357.
- Field, M., Duka, T., Eastwood, B., Child, R., Santarcangelo, M., & Gayton, M. (2007). Experimental manipulation of attentional biases in heavy drinkers: Do the effects generalize? *Psychopharmacology, 192*, 593-608.
- Field, M., Mogg, K., & Bradley, B. P. (2005). Craving and cognitive biases for alcohol cues in social drinkers. *Alcohol and Alcoholism, 40*, 504-510.
- 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. *Psychopharmacology, 176*, 88-93.
- Fischer, S., Anderson, K. G., & Smith, G. T. (2004). Coping with distress by eating or drinking: Role of trait urgency and expectancies. *Psychology of Addictive Behaviors, 18*, 269-274.

- Fischer, S., Smith, G. T., Anderson, K. G., & Flory, K. (2003). Expectancy influences the operation of personality on behavior. *Psychology of Addictive Behaviors, 17*, 108-114.
- Flannery, B. A., Poole, S. A., Gallop, R. J., & Volpicelli, J. R. (2003). Alcohol craving predicts drinking during treatment: An analysis of three assessment instruments. *Journal of Studies on Alcohol, 64*, 120-126.
- Fox, H. C., Bergquist, K. L., Hong, K., & Sinha, R. (2007). Stress-induced alcohol cue-induced craving in recently abstinent alcohol-dependent individuals. *Alcoholism: Clinical and Experimental Research, 31*, 395-403.
- Hingson, R. W., Heeren, T., Winter, M., & Wechsler, H. (2005). Magnitude of alcohol-related mortality and morbidity among US college students ages 18-24: Changes from 1998 to 2001. *Annual Review of Public Health, 26*, 259-279.
- Hingson, R. W., Zha, W., & Weitzman, E. R. (2009). Magnitude and trends in alcohol-related mortality and morbidity among U.S. college students ages 18-24, 1998-2005. *Journal of Studies on Alcohol and Drugs, 16*, 12-20.
- Jackson, J. S., William, D. R., & Gomberg, E. S. L. (1998). A life-course perspective on aging and alcohol use and abuse among African Americans. In E. S. L. Gomberg, A. M. Hegedus, & R. A. Zucker (Eds.), *Alcohol Problems and Aging*. NIDA Research Monograph, vol. 33. (pp. 61 – 112) Bethesda, MD: National Institute on Alcohol Abuse and Alcoholism.

- Johnson, B. A., Cloninger, C. R., Roache, J. D., Bordnick, P. S., & Ruiz, P. (2000). Age of onset as a discriminator between alcoholic subtypes in a treatment-seeking outpatient population. *The American Journal of Addiction, 9*, 17-27.
- Kareken, D. A., Claus, E. D., Sabri, M., Dzimidzic, M., Kosobud, A. E. K., Radnovich, A. J., Hector, D., Ramchandani, V. A., O'Connor, S. J., Lowe, M., & Li, T. (2004). Alcohol-related olfactory cues activate the nucleus accumbens and ventral tegmental area in high risk drinkers: Preliminary findings. *Alcoholism: Clinical and Experimental Research, 28*, 550-557.
- Kline, R. B. (1998). *Principles and practice of structured equation modeling*. New York: Guilford Press.
- Knight, J. R., Wechsler, H., Kuo, M., Seibring, M., Weitzman, E. R., & Schuckit, M. A. (2002). Alcohol abuse and dependence among US college students. *Journal of Studies on Alcohol, 63*, 263-270.
- Kranzler, H. R., Mulgrew, C. L., Modesto-Lowe, V., & Burleson, J. A. (1999). Validity of the Obsessive Compulsive Drinking Scale (OCDS): Does craving predict drinking behavior? *Alcoholism: Clinical and Experimental Research, 23*, 108-114.
- Leigh, B. C., & Stacy, A. W. (2004). Alcohol expectancies and drinking in different age groups. *Addiction, 99*, 215-227.
- Lynam, D., Smith, G. T., Cyders, M. A., Fischer, S., & Whiteside, S. A. (2007). The UPPS-P: A multidimensional measure of risk for impulsive behavior. *Unpublished technical report*.

- MacKillop, J. (2006). Factor structure of the alcohol urge questionnaire under neutral conditions and during a cue-elicited urge state. *Alcoholism: Clinical and Experimental Research, 30*, 1315-1321.
- Mason, B. J., Light, J. M., Escher, T., & Drobles, D. J. (2008). Effect of positive and negative affective stimuli and beverage cues on measures of craving. *Psychopharmacology, 200*, 141-150.
- Miller, W. R., Westerberg, V. S., Harris, R. J., & Tonigan, J. S. (1996). What predicts relapse? Prospective testing of antecedent models. *Addiction, 91*, S155-S171.
- Monti, P. M., Abrams, D. B., Binkoff, J. A., Swick, W. R., Liepman, M. R., Nirenberg, T. D., & Rohsenow, D. J. (1990). Communication skills training, communication skills training with family, and cognitive behavioral mood management training for alcoholics. *Journal of Studies on Alcohol, 51*, 263-270.
- Monti, P. M., Rohsenow, D. J., Rubonis, A. V., Niaura, R. S., Sirota, A. D., Colby, S. M., & Abrams, D. B. (1993). Alcohol cue reactivity: Effects of detoxification and extended exposure. *Journal of Studies on Alcohol, 54*, 235-245.
- Nolen-Hoeksema, S. (2004). Gender differences in risk factors and consequences for alcohol use and problems. *Clinical Psychology Review, 24*, 981-1010.
- Pavlick, M. N. (2007). *The relationship of cue-exposure, reactivity, and craving in binge-drinking college students*. Unpublished doctor dissertation, Bowling Green State University, Bowling Green, OH. (OhioLINK No. bgsu1182736064). Retrieved February 29, 2012, from OhioLINK.

- Pomerleau, O. F., Fertig, J., Baker, L., & Cooney, N. (1983). Reactivity to alcohol cues in alcoholics and non-alcoholics: Implications for a stimulus control analysis of drinking. *Addictive Behaviors, 8*, 1-10.
- Rohsenow, D. J., & Monti, P. M. (1999). Does urge to drink predict relapse after treatment? *Alcohol Research and Health, 23*, 225-232.
- Rohsenow, D. J., Monti, P. M., Rubonis, A. V., Sirota, A. D., Niaura, R. S., Colby, S. M., Wunschel, S. M., & Abrams, D. B. (1994). Cue reactivity as a predictor of drinking among male alcoholics. *Journal of Consulting and Clinical Psychology, 62*, 620-626.
- Rubonis, A. V., Colby, S. M., Monti, P. M., Rohsenow, D. J., Gulliver, S. B., & Sirota, A. D. (1994). Alcohol cue reactivity and mood induction in male and female alcoholics. *Journal of Studies on Alcohol, 55*, 487-494.
- Settles, R. F., Cyders, M. A., & Smith, G. T. (2010). Longitudinal validation of the acquired preparedness model of drinking risk. *Psychology of Addictive Behaviors, 24*, 198-208.
- Siegel, S. (1983). Classical conditioning, drug tolerance and drug dependence. *Research Advances in Alcohol and Drug Problems, 7*, 207-246.
- Sinha, R., Fox, H. C., Hong, K. A., Bergquist, K., Bhagwagar, Z., & Siedlarz, K. M. (2009). Enhanced negative emotion and alcohol craving, and altered physiological responses following stress and cue exposure in alcohol dependent individuals. *Neuropsychopharmacology, 34*, 1198-1208.

- Smith, G. T., Fischer S., Cyders, M. A., Annus, A. M., Spillane, N. S., & McCarthy, D. M. (2007). On the validity and utility of discriminating among impulsivity-like traits. *Assessment, 14*, 155-170.
- Steinman, K., Ferketich, A., & Sahr, T. (2006). The dose-response relationship of adolescent religious activity and substance use: Variation across demographic groups. *Health Education and Behavior, 35*, 22-43.
- Stormark, K. M., Laberg, J. C., Bjerland, T., Nordby, H., & Hugdahl, K. (1995). Autonomic cued reactivity in alcoholics: The effect of olfactory stimuli. *Addictive Behaviors, 20*, 571-584.
- White, H. R., McMorris, B. J., Catalano, R. F., Fleming, C. B., Haggerty, K. P., & Abbott, R. D. (2006). Increases in alcohol and marijuana use during the transition out of high school into emerging adulthood: The effects of leaving home, going to college, and high school protective factors. *Journal of Studies on Alcohol, 67*, 810-822.
- Wikler, A. (1973). Conditioning of successive adaptive responses to the initial effects of drugs. *Conditioned Reflex, 8*, 193-210.

APPENDICES

Appendix A: Differences among Variables

Table A1

Differences in Categorical Variables between Included and Excluded Participants

		Excluded Participants		Included Participants		χ^2	p- value
		Frequency	Percent	Frequency	Percent		
Gender	Male	132	29.4	70	29.3	.003	0.96
	Female	317	70.6	169	70.7		
Race	Caucasian	307	67.9	180	75	14.68	0.01
	Hispanic	36	8	14	5.8		
	Asian	12	2.7	5	2.1		
	Indian	2	0.4	2	0.8		
	African	62	13.7	26	10.8		
	Other	33	7.3	13	5.4		

Note. Differences were tested using chi-square test of independence.

Table A2

Differences in Continuous Variables between Included and Excluded Participants

	Excluded Participants		Included Participants		t-test	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>t-value</i>	<i>p-value</i>
Age	22.00	5.87	19.37	1.65	6.65	<.001
Problematic Drinking	4.49	3.93	8.43	4.19	-10.27	<.001
Alcohol Cravings	.27	.30	.51	.37	-7.41	<.001
Cue Reactivity	5.35	7.64	8.66	8.85	-4.19	<.001
Negative Urgency	1.20	.59	1.37	.56	-3.18	.002
Positive Urgency	.73	.60	.94	.55	-3.88	<.001

Note. Differences were tested using independent samples t-test.

Appendix B: T-Tests, Correlations, and Simultaneous Regression

Table B1

Correlations among Predictors and Outcomes

Variables	1	2	3	4	5
1. DRINK	1	.57**	.26**	.39**	.47**
2. CRAV		1	.32**	.44**	.47**
3. CUE			1	.15*	.13*
4. NUR				1	.67**
5. PUR					1

Note. * indicates $p < 0.05$, ** indicates $p < 0.01$. DRINK = problematic drinking, CRAV = alcohol cravings, CUE = cue reactivity, NUR = negative urgency, PUR = positive urgency.

Table B2

T-Test Analyses

	Non-Alcohol Pictures		Alcohol Pictures		t-test	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>t-value</i>	<i>p-value</i>
Cue Reactivity	7.63	8.07	8.66	8.85	6.05	<.001

	Men		Women		t-test	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>t-value</i>	<i>p-value</i>
Problematic Drinking	9.22	4.41	8.16	4.05	1.79	.08

Table B3

Effect of Urgency on Cue Reactivity, Over and Above Alcohol Cravings

	Negative Urgency				Positive Urgency			
	<i>b</i>	<i>SE</i>	β	<i>p</i>	<i>b</i>	<i>SE</i>	β	<i>p</i>
Urgency	1.53	1.02	.10	.13	2.06	1.04	.13	.05
Alcohol Cravings	9.86	1.52	.42	<.001	9.43	1.54	.40	<.001

Note. Bolded coefficients were significant at $p < .05$.

Appendix C: Main Results

Table C1

Interactions between Alcohol Cravings and Urgency on Problematic Drinking

Predictors	Negative Urgency				Positive Urgency			
	<i>b</i>	<i>SE</i>	β	<i>p</i>	<i>b</i>	<i>SE</i>	β	<i>p</i>
Gender	-1.49	.48	-.16	<.001	-1.10	.47	-.12	.02
Age	-.05	.13	-.02	.70	.01	.13	.00	.94
Ethnicity	-.05	.13	-.02	.73	-.10	.13	-.04	.46
Urgency	1.35	.44	.18	<.001	1.79	.45	.24	<.001
Alcohol Cravings	6.09	.70	.54	<.001	5.39	.70	.48	<.001
Urgency X Cravings	-2.28	1.06	-.12	.03	-.75	.99	-.04	.45

Note. Bolded coefficients were significant at $p < .05$. All values were taken from the final step of the analyses.

Table C2

Interactions between Alcohol Cravings and Cue Reactivity on Problematic Drinking

Predictors	<i>b</i>	<i>SE</i>	β	<i>p</i>
Gender	-1.23	.49	-.13	.01
Age	-.08	.14	-.03	.55
Ethnicity	-.08	.14	-.03	.55
Cue Reactivity	.02	.03	.04	.48
Alcohol Cravings	6.55	.71	.59	.00
Reactivity X Cravings	-.06	.06	-.06	.32

Note. Bolded coefficients were significant at $p < .05$. All values were taken from the final step of the analyses.

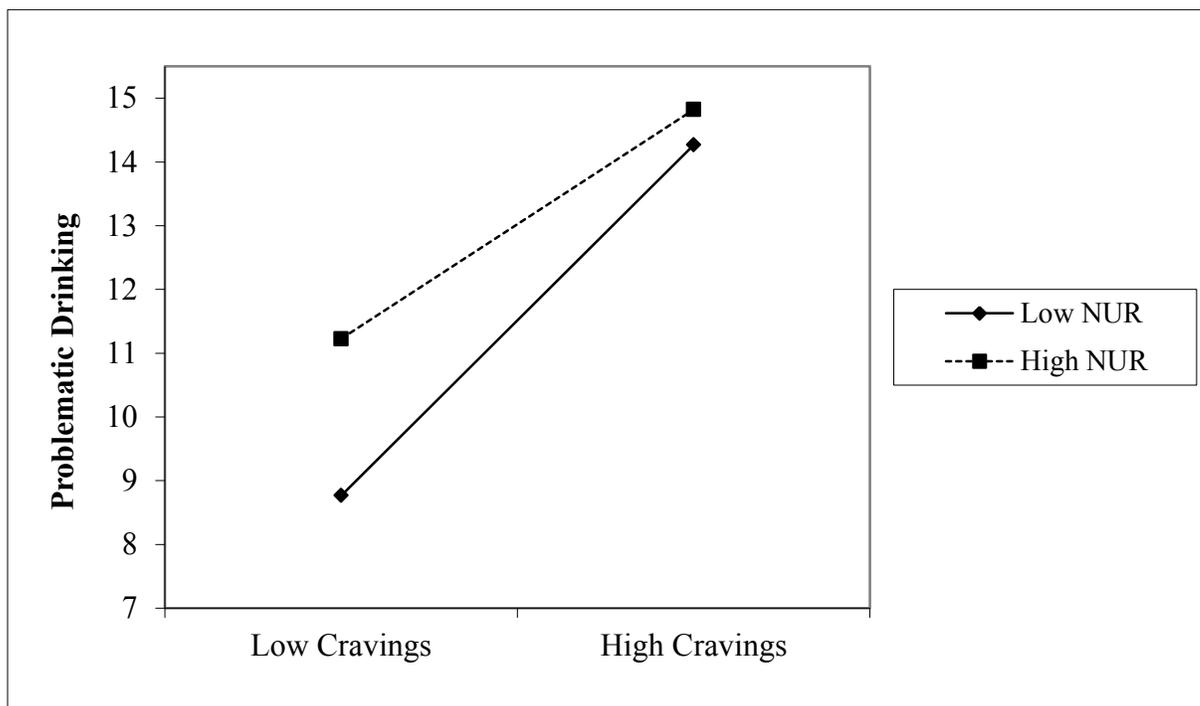
Table C3

Three-Way Interactions among Urgency, Cue Reactivity, and Alcohol Cravings

Predictors	Negative Urgency				Positive Urgency			
	<i>b</i>	<i>SE</i>	β	<i>p</i>	<i>b</i>	<i>SE</i>	β	<i>p</i>
Gender	-1.48	.48	-.16	<.001	-1.04	.48	-.11	.03
Age	-.02	.13	-.01	.89	.05	.14	.02	.74
Ethnicity	-.03	.14	-.01	.82	-.08	.13	-.03	.54
Cue Reactivity	.01	.03	.03	.67	.02	.03	.04	.52
Alcohol Cravings	6.07	.78	.54	<.001	5.47	.76	.49	<.001
Urgency	1.58	.46	.21	<.001	2.01	.47	.27	<.001
Reactivity X Cravings	.07	.08	.07	.34	-.01	.08	-.01	.92
Urgency X Cravings	-1.70	1.18	-.09	.15	.47	1.26	.03	.71
Urgency X Reactivity	.02	.06	.02	.76	.03	.05	.04	.58
Three Way Interaction	-.21	.10	-.16	.04	-.16	.09	-.16	.08

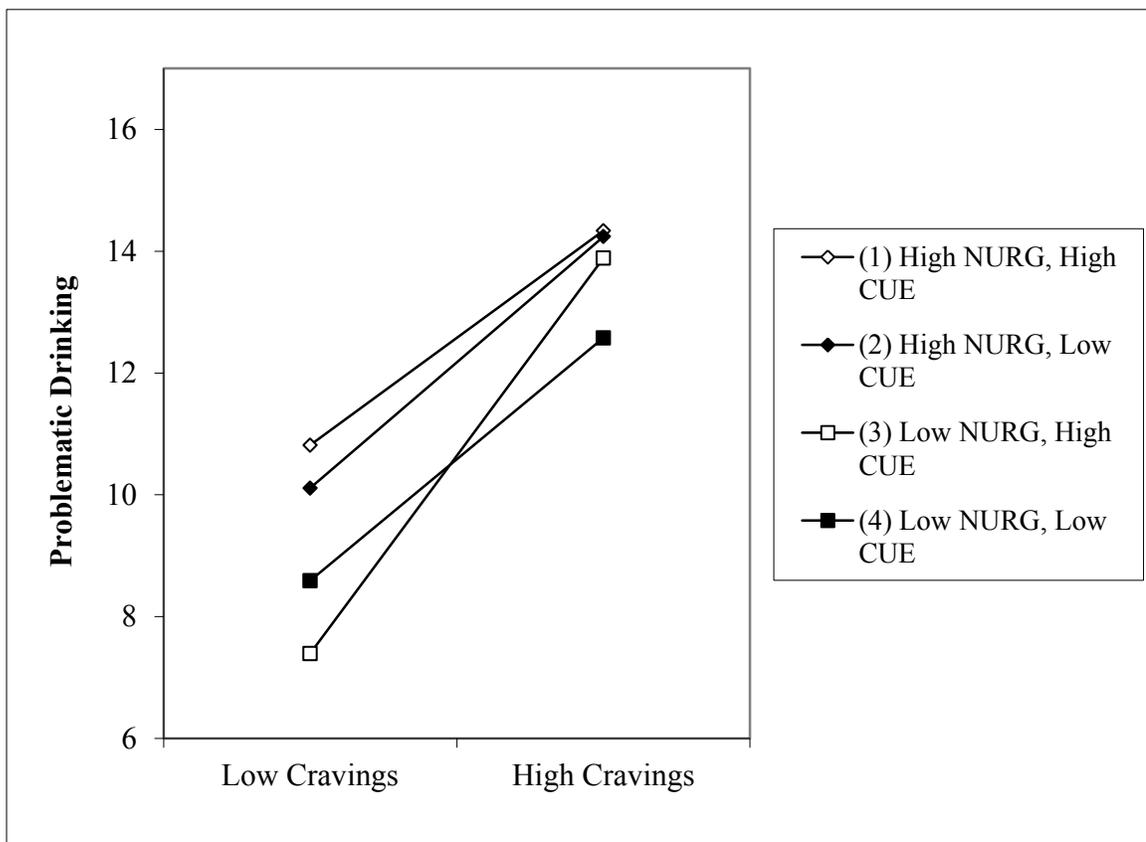
Note. Bolded coefficients were significant at $p < .05$. All values were taken from the final step of the analyses.

Appendix D: Interaction Figures



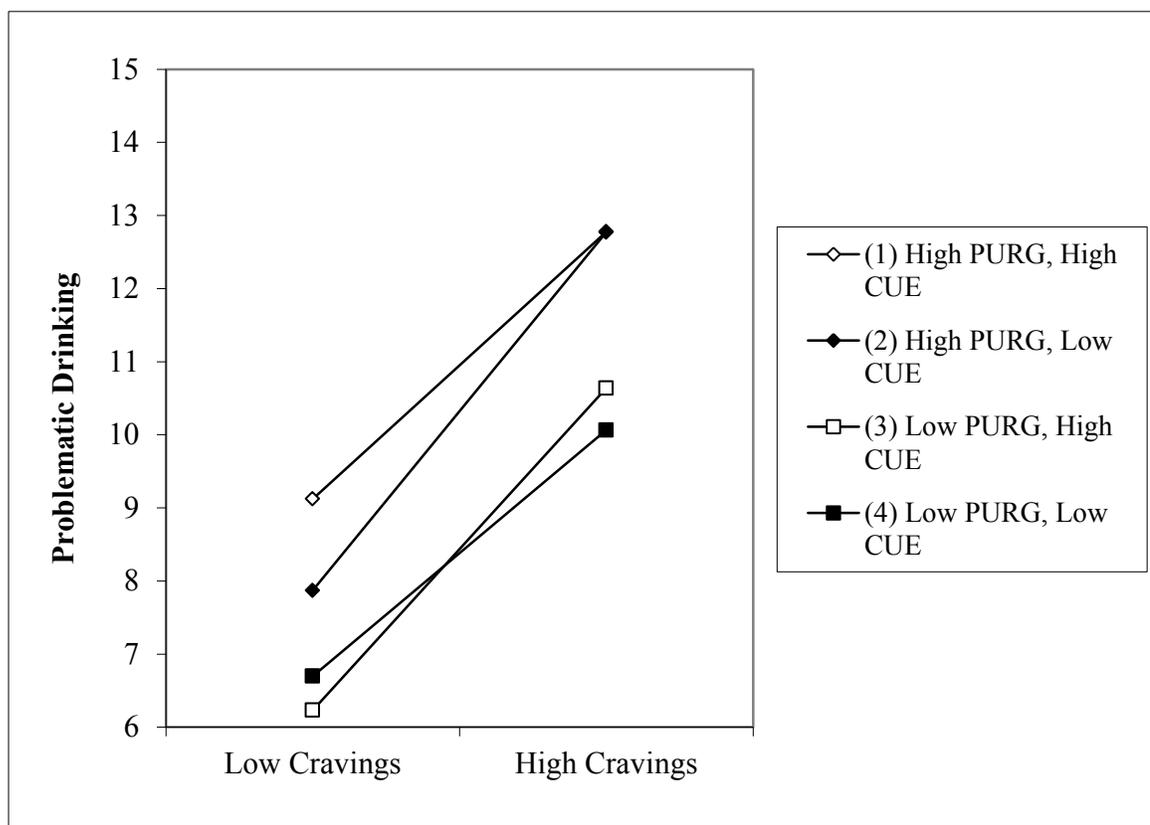
Note. Significant difference between the two slopes.

Figure D1



Note. Significant difference between slope (1) and slope (3).

Figure D2



Note. No significant differences among slopes.

Figure D3