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Alcohol-related attentional bias: The role of support networks

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ALCOHOL-RELATED ATTENTIONAL BIAS: THE ROLE OF SUPPORT NETWORKS

BY

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THESIS

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ABSTRACT

Previous research has shown that drinking levels are influenced by social networks, yet causal mechanisms that explain this relationship are poorly understood. The present study assessed alcohol-related attentional bias as a hypothesized mechanism connecting social support with drinking. Using a 10-minute writing assignment, 84 participants were randomly assigned to focus on a network member that was either a heavy or light drinker. Modified Stroop tests assessed alcohol-related attentional bias before and after the assignment by measuring response latencies for naming font colors for alcohol and neutral words presented on a computer screen. Drinking quantity, alcohol-related problems, and acceptance were assessed using self-report questionnaires. Analyses were conducted to test the impact of the writing task on alcohol-related attentional bias, the mediating relationship of attentional bias on social support and drinking, and the moderating role of acceptance on attentional bias and drinking. Results indicate that, relative to neutral words, response latencies for alcohol words were not significantly affected by the writing task condition in the expected direction. Contrary to the expected results, low-intensity drinkers had significantly longer response latencies to alcohol words than neutral words at baseline, and high-intensity drinkers had significantly longer response latencies to alcohol words during the post-writing-task Stroop test, collapsing across experimental conditions. Attentional bias was not found to mediate social support and participant drinking, and acceptance did not moderate the relationship between attentional bias and drinking. Further probing of the Stroop test suggested that the test may have poor reliability that may have contributed to the failure to support the study hypotheses.

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CHAPTER 1

It is estimated that, worldwide, more than 75 million individuals currently suffer from alcohol use disorders (AUDs) (World Health Organization, 2004). AUDs contribute to a number of public health concerns, and it is estimated that between \$210 and \$650 billion per year are lost each year due to costs associated with health care, premature mortality, lost wages, unemployment, criminal justice, and criminal activity due to alcohol consumption (Baumberg, 2006). Several treatments for AUDs have been demonstrated to reduce drinking (Hallgren, Greenfield, Ladd, Glynn, & McCrady, in press). Current research on AUDs and their treatments largely have focused on achieving a better understanding of the mechanisms that underlie addictive behaviors and their treatments in an effort to isolate those specific factors and incorporate them in treatment and prevention programs (Longabaugh et al., 2005).

Cognitive models of AUDs posit that drinking behavior is guided by automatic or implicit processes (Stacy & Wiers, 2006). Such cognitive processes are said to be fast acting, automatic, and outside of executive control (Albery, Sharma, Niazi, & Moss, 2006). Among these processes, attentional bias for alcohol-related stimuli has been studied in an effort to understand how cognition is involved in the maintenance and treatment of addictive behaviors.

In alcohol users, it is thought that memory structures of alcohol-related cognitions are formulated at the implicit level such that when an alcohol cue is presented the activation of salient memory structures occurs automatically, and the alcohol cue occupies attention (Albery et al., 2006). Implicit cognitive processes, such as attentional bias, have been hypothesized to contribute actively to the development and maintenance of addictive behaviors (Weinstein & Cox, 2006) and are hypothesized to be mediating factors between the presentation of addiction-related stimuli and subsequent behavioral responses such as relapse to drinking (Franken, 2003). The automatic attentional bias toward substance-related cues may guide behavior even when it is inconsistent with an individual's conscious goals (Field, 2006), and may create increased potential for relapse. Attentional bias and craving are thought to have a reciprocal relationship where alcohol cravings increase attentional bias toward alcohol-related cues, and concurrently, the increase in attention toward alcohol cues may increase alcohol cravings (see Field & Cox, 2008). In this way, it is hypothesized that an attentional bias toward alcohol cues increases motivational incentives to consume alcohol and influences drinking behavior.

Measures of implicit cognition contribute unique information that cannot be provided by self-report. Assessments of implicit cognition have been shown to account for variance in substance-use behavior beyond what is accounted for by explicit measures (McCarthy & Thompsen, 2006; Ostafin & Palfai, 2006), and several studies have demonstrated that attentional bias toward alcohol-related stimuli is associated with drinking quantity (Bruce & Jones, 2004; Fadardi & Cox, 2008) and a diagnosis of alcohol dependence (Johnsen, Laberg, Cox, Vaksdal, & Hugdahl, 1994; Lusher, Chandler, & Ball, 2004; Sharma, Albery, & Cook, 2001). Cox, Hogan, Kristian, and Race (2002) demonstrated that participants who successfully completed treatment for alcohol dependence showed patterns of alcohol-related attentional bias over the course of treatment that were different from those who did not successfully complete the treatment. Specifically, those who were unsuccessful had previously demonstrated a significant increase in alcohol-related attentional bias over the course of treatment, whereas those who were successful had relatively little change in their attentional bias. These results suggest that a better understanding of factors that increase attentional bias may have a practical clinical utility for predicting relapse in alcohol-dependent individuals.

Experiments have demonstrated that attentional bias for alcohol cues can be increased by direct exposure to alcohol cues. For example, attentional biases for alcohol cues have been found to be stronger among drinkers who are primed with low doses of alcohol rather than non-alcoholic beverages (Duka & Townshend, 2004). Visual priming with alcohol-related images has been shown to cause a significant increase in alcohol-related attentional bias compared to visual priming with neutral images in heavy college drinkers (Cox, Yeates, & Regan, 1999). Computerized attentional retraining procedures also have been shown to shift attentional bias toward or away from alcohol cues and to influence drinking behavior. Retraining procedures have used a modified dot-probe task in which participants are simultaneously presented with an alcohol cue (e.g., beer bottles) and a neutral cue (e.g., water bottles), and are instructed to search for a probe that appears in the same place as either of the cues, then indicate the location of the probe as quickly as possible. To retrain attention, the task is completed with the probe consistently present in place of either alcohol cues (attend-alcohol) or neutral cues (avoid-alcohol). Single sessions of computerized attentional retraining were shown to be successful in increasing (attend-alcohol) or decreasing (avoid-alcohol) attentional bias (Field et al., 2007; Field & Eastwood, 2005), and have been successful at increasing motivation to drink (Field et al., 2007; Field & Eastwood, 2005) and quantity of drinking (Field & Eastwood, 2005) among heavy drinking university students in the attend-alcohol groups. Despite increasing drinking motivation and consumption in the attend-alcohol groups, the training procedure was not shown to decrease motivation or quantity of drinking for those in the avoid-alcohol groups, suggesting that attentional retraining can impact drinking motivation and alcohol consumption, but only in a direction that increases these attributes.

While these attentional retraining experiments have not demonstrated utility in manipulating attentional bias to reduce drinking, it is possible that incorporating other factors known to influence behavior in conjunction with attentional retraining may be more successful. The finding that reducing attentional bias toward alcohol cues does not inherently reduce drinking motivation or alcohol consumption supports the hypothesis that salience of stimuli is a crucial component in attentional bias (Albery et al., 2006), since it is likely that the neutral stimuli toward which attention was trained (e.g., bottles of water) were not highly salient to the participants, and thus had little or no effect on behavior. In other words, it is possible that some attentional-retraining procedures have failed to reduce drinking because they did not incorporate personally salient components, other than alcohol, that might influence motivation to drink less.

Incorporating personally salient, ideographic components may be a particularly efficacious approach to influencing attentional bias and subsequent behavior. One procedure that incorporated personal goals and individualized feedback in addition to attentional retraining procedures, the Alcohol Attentional Control Training Program (AACTP, Fadardi & Cox, 2009), has been successful at reducing both attentional bias and subsequent alcohol consumption. Using a within-subjects design, AACTP was found to reduce attentional bias in participants classified as hazardous and harmful drinkers, and subsequently reduced drinking quantity and drinking-related consequences in harmful drinkers both immediately following the training and at three-month follow-ups (Fadardi & Cox, 2009). The intervention used attentional retraining techniques similar to those described above (Field et al., 2007; Field & Eastwood, 2005), but also engaged participants in activities that might enhance the personal saliency of the program such as incorporating personalized feedback and goal-setting with regard to their attentional bias. While personalized feedback and goal-setting were conducted regarding participants' attentional biases rather than actual drinking behavior, personalized feedback and goal-setting with relation to actual drinking are common ingredients of effective alcohol treatments (Moos, 2007). Finally, while preliminary data suggest that AACTP may be efficacious in reducing drinking, it should be noted that the study only used a within-subjects design and did not utilize a no-treatment control group; therefore, the efficacy of the program has not yet been demonstrated through a randomized trial design.

There is emerging evidence suggesting that in addition to previous drinking levels and exposure to alcohol cues, attentional bias may be influenced by individual motivational and social factors. For example, attentional bias for alcohol cues was activated differently for individuals whose drinking motivation was based on mood enhancement rather than coping with negative affect after experiencing a positive mood induction through music (Birch et al., 2008; Grant, Stewart, & Birch, 2007). Those with drinking motivation based on coping with negative affect did not activate attentional bias after either positive or negative musical mood induction; those with drinking motivation based on positive mood enhancement activated a significant bias for alcohol-related stimuli after positive mood induction. Drinking motivation based on coping with social anxiety also has been shown to correlate significantly with attentional bias for alcohol cues (Carrigan, Drobes, & Randall, 2004); this relationship maintained marginal significance even when controlling for level of alcohol dependence. The level at which a person reports drinking in response to social conflict also has been found to be associated with shorter response latencies for naming alcohol-related words after priming with anxiety cues (Austin & Smith, 2008), although this study assessed implicit associative memory networks using a lexical decision task and did not directly assess attentional bias.

Although certain motivational factors have been shown to be predictive of attentional bias, no studies to date have directly evaluated the impact of social support on attentional bias. Research has consistently demonstrated that factors within social networks are associated with drinking levels before (Manuel, McCrady, Epstein, Cook, & Tonigan, 2007) and after treatment (Beattie & Longabaugh, 1999; Groh, Olson, Jason, Davis, & Ferrari, 2007; McAweeney, Zucker, Fitzgerald, Puttler, & Wong, 2005; McCrady, 2004; Zywiak, Longabaugh, & Wirtz, 2002). Alcohol-related social support is of particular interest, as this has been shown to predict short- and long-term substance-use outcomes, whereas general social support has been shown to be unrelated to long-term drinking outcomes (Beattie & Longabaugh, 1997, 1999). Although social support factors are known to predict drinking outcomes, the mechanisms through which these factors operate are not yet fully understood (Longabaugh & Galanter, 2003). It has been hypothesized that intrapersonal factors, including cognitive processes, are likely involved as mediating factors between social support and drinking outcomes (Hunter-Reel, McCrady, & Hildebrandt, 2009).

A better understanding of the influence of social support on alcohol-related attentional bias would present several implications for theory and practice. The potential finding that social support influences attentional bias would provide support for the importance of social network cues in shaping moment-to-moment attentional bias, would offer an intrinsic factor to be used for manipulating attentional bias, and would suggest that incorporating personally salient social network factors might influence the efficacy of attentional retraining paradigms. A better understanding of this topic could open the door for further research investigating attentional bias as a mechanism of change in treatments that directly implicate social support factors, such as Alcohol Behavioral Couple Therapy (McCrady & Epstein, 2009), the Community Reinforcement Approach (Meyers & Smith, 1995), and Twelve-Step-based therapies (Sheehan & Owen, 1999), and may provide further support for utilizing treatments that engage or restructure support networks.

The goal of the present study was to assess the connection between alcohol-related social support, attentional bias for alcohol-related stimuli, and alcohol consumption. More specifically, since network support for drinking and attentional bias are each independently associated with alcohol consumption (Fadardi & Cox, 2008; Manuel et al., 2007), we tested attentional bias as a potential mediator for the relationship between social support and drinking. We hypothesized that drinking quantity would be positively correlated with both attentional bias and alcohol-related social support, and that attentional bias would statistically mediate the relationship between alcohol-related social support and drinking behavior.

To further examine potential causality in the relationship between alcohol-related support and attentional bias, we tested the impact of focusing on heavy and light drinking network members on attentional bias. If activating memory structures relating to network members who are heavy drinkers also activated memory structures relating to alcohol itself, we expected the alcohol-related memory activation to increase the saliency of alcohol-related stimuli. Thus, we hypothesized that participants randomly assigned to complete a writing task about a heavy drinking network member consequently would be more distracted by alcohol cues in a color-naming task when compared to participants assigned to write about a light drinking or abstaining network member, indicating different levels of attentional bias caused by focusing on different members of a support network.

We also looked separately at acceptance as a potential moderator for the relationship between attentional bias and drinking behavior. Although counterintuitive, conscious attempts to avoid alcohol stimuli may actually perpetuate additional attentional bias toward alcohol-related cues (Stormark, Field, Hugdahl, & Horowitz, 1997), and deliberate attempts to avoid alcohol-related cues may lead to rebound effects (Palfai, Colby, Monti, & Rohsenow, 1997) and poorer treatment outcomes (Bowen, Witkiewitz, Dillworth, & Marlatt, 2007), ultimately leading to behavior that is inconsistent with one's conscious goals. Mindfulness aims to change the function of a person's automatic responses rather than change the content of the responses (Hayes, 2004), and individuals with higher levels of mindfulness may be more prone to accept, rather than avoid or act on, automatic motivation that conflicts with conscious goals. Acceptance, a component of mindfulness considered to be "nonjudgmental embracing of experience in the here and now" (Hayes, 2004, p. 656), has been found to moderate the relationship between alcohol-related implicit associations and drinking behavior such that individuals with low acceptance demonstrate a stronger relationship between implicit associations and drinking than do individuals with high acceptance (Ostafin & Marlatt, 2008). Understanding the potential moderating effects that mindfulness has on the relationship between attentional bias and alcohol consumption would provide theoretical insight into whether acceptance has moderating effects on implicit association alone or on a broader set of automatic cognitions, including attentional bias, and may provide support for increasing acceptance as a goal in clinical treatments of alcohol disorders. In light of this, we also tested the potential moderating effect of acceptance on the relationship between alcohol-related attentional bias and drinking quantity, hypothesizing a similar moderating effect for attentional bias that Ostafin and Marlatt (2008) found with implicit association.

CHAPTER 2

Method

Participants

Participants were undergraduate university students receiving course credit for their participation in the study, and were recruited through a university website listing available research credit opportunities. Recruitment advertisements described the study as an investigation of social networks and individual attitudes, and did not explicitly advertise the study as being related to alcohol, attentional bias, or mindfulness. To be eligible for the study, participants must have had at least one binge-drinking episode within the previous 30 days, defined by the consumption at least four alcoholic beverages in a single drinking episode for women, and five alcoholic beverages for men. This criterion was confirmed before participants signed up for the study by asking participants a small battery of questions on a variety of topics to maintain ambiguity about the nature of the study, and included one item to assess the maximum number of drinks they had consumed in the last 30 days.

Fadardi and Cox (2008) reviewed five studies of attentional bias toward alcohol cues that used the modified Stroop test in university students and found an average estimated effect size of $f^2 = .19$. Entering this effect size into G*Power (Erdfelder, Faul, & Buchner, 1996) with a .05 alpha level and three predictor variables (main effects for group and word type, and interaction between the two) demonstrated that a sample size of 62 participants would detect significant effects with .80 power, and a sample size of 80 participants would provide .90 power. Factors serving as covariates were not considered in the power analyses to maintain a conservative sample-size estimate.

Of the 405 students who completed the eligibility pre-screen, 140 met eligibility criteria for enrollment into the study, and 94 students scheduled appointments and completed the study. Data from five students were incomplete due to computer malfunction during the Stroop test or the Timeline Followback, and five more participants were removed from the final analysis after examination of their Timeline Followback data revealed no binge drinking episodes within the followback period. The remaining sample of 84 participants was used for all analyses reported in this study.

Measures

Alcohol-related attentional bias. An alcohol Stroop test (Johnsen et al., 1994) was used to measure attentional bias toward alcohol-related words. Stroop tasks incorporating self-relevant words have demonstrated good test-retest reliability (Siegrist, 1997), and although alcohol Stroop tests have demonstrated good convergent, discriminant, and predictive validity (see Cox, Fadardi, & Pothos, 2006 for a review), no data on the reliability of alcohol Stroop tests have been published to our awareness. During the test, single words matched for length and frequency of usage either related to alcohol (e.g., "cocktail") or a neutral topic (e.g., "sweater"; Birch et al., 2008, see Table 1 for the list of words) were presented sequentially in a randomized order on a computer screen with red, yellow, blue, or green font color and white background following the guidelines outlined by Cox et al. (2006). Participants were instructed to respond by identifying the font color of the word using the keyboard while ignoring specific word meanings, with response latencies and errors being recorded. Keyboards were marked with colored stickers that match the corresponding colors for responses. Classic Stroop tests (e.g., the word "red" printed in green font) have been shown to have larger interference effects when participants respond orally rather than manually, and it is thought that this is due to the target word and font color both having similar semantic aspects (i.e., both are colors). Unlike classic Stroop tests, the alcohol Stroop test uses target words unrelated to font colors, and thus the response modality for this test is thought to be less critical than for classic Stroop tests (Cox et al., 2006).

The alcohol Stroop test was programmed using DMDX software (Forster & Forster, 2003). DMDX has a reported display accuracy within 4 ms and can accurately record reaction times within 2 ms (Forster & Forster, 2003). The test was administered using two Windows computers with adequate processing speeds and memory capacities for accurately displaying stimuli and recording response times (Forster & Forster, 2003). Participants completed the study in an area that provided adequate privacy and viewed the stimuli at a distance that was comfortable for them.

Support network. A version of the Important People Instrument (IPI, Longabaugh, 2001) adapted for college students who are not considering alcohol treatment assessed levels of importance and alcohol-related support for each social support network member (see Appendix). The IPI first prompted participants to list significant individuals who were friends, romantic partners, family members, coworkers, classmates, associates in extra-curricular activities, and cohabitants. Once these members were listed, the IPI then assessed three principal components identified by Groh et al.

(2007) for each network member, providing scales for general importance (e.g., 0 = low importance, 5 = high importance), drinking behavior (e.g., -2 = rare or no drinking, +2 = heavy drinking), and encouragement for the participant's drinking (e.g., -2 = low encouragement, +2 = strong encouragement). The present study used network members' drinking behavior rather than members' encouragement for drinking as the variable of interest based on the recommendations of Groh et al. (2007), who found participant drinking was predicted more by support network drinking behavior than network encouragement for drinking. In addition to the original IPI questions included by Longabaugh (2001), additional questions unrelated to alcohol use (e.g., level of education and hobbies of each network member) were included to minimize the influence of the assessment in priming alcohol-related cognitions for the writing task and post-writing task Stroop test. In general, the IPI has been shown to have high 2-3 day test-retest reliability (r = .95; Longabaugh, Wirtz, Zweben, & Stout, 1998), good discriminant and predictive validity (Groh et al., 2007), and is suited for customization to fit the specific needs of a given study (Groh et al., 2007).

Previous drinking behavior. Participant drinking quantity and frequency were assessed using a computerized Alcohol Timeline Followback questionnaire (Sobell & Sobell, 1992) to calculate the percentage of drinking days over the 90-day period (drinking frequency) and the mean number of drinks per drinking day (drinking intensity) over the previous 90 days. Participants were given calendars marked with important holidays and academic dates to provide estimates of the number of drinks they consumed for each drinking day over the 90 day period. We selected the 90-day time period as this has been used frequently in studies of college drinkers. The 90-day Timeline Followback has shown good test-retest reliability in community samples (Sobell, Sobell, Leo, & Cancilla, 1988), and has been shown to yield similar results when administered using electronic and paper-and-pencil-based assessments in problem drinkers (Sobell, Brown, Leo, & Sobell, 1996) and college drinkers (LaBrie, Earleywine, Lamb, & Shelesky, 2006).

Drinking-related problems. The Rutgers Alcohol Problem Index (RAPI; White & Labouvie, 1989) is a unidimensional questionnaire assessing the frequency of negative alcohol-related consequences that the drinker has experienced within the previous year. The RAPI contains 23 items designed specifically to detect negative alcohol-related consequences commonly experienced by college students (e.g., "not able to do your homework or study for a test."). The measure is well validated and has demonstrated good test-retest reliability when administered to college students in paper-and-pencil- and internet-based formats ($r = .88$; Miller et al., 2002).

Demographics. Demographic data were collected using a questionnaire form of the CASAA Demographic Interview (CASAA Research Division, 1997) to assess information regarding age, sex, year in college, race, ethnicity, income level, and marital status. Information regarding participants' language fluency also was collected, since this may affect color-response latencies due to semantic cues in the Stroop test. Current living situation (e.g., dormitory, sorority/fraternity house, parent or other off-campus housing) also was assessed, since this may moderate the level of contact with members of social networks.

Philadelphia Mindfulness Scale. The Philadelphia Mindfulness Scale (Cardaciotto, Herbert, Forman, Moitra, & Farrow, 2008) is a brief 20-question assessment that provides independent scales for acceptance (e.g., "I try to stay busy to keep thoughts or feelings from coming to mind") and present-moment awareness (e.g., "when I walk outside, I am aware of smells or how the air feels against my face"). In the present study, the acceptance scale was of particular interest, since we hypothesized that individuals who are more accepting of their automatic internal experiences would be less likely to act in accordance with them, as has been found using measures of implicit association (Ostafin & Marlatt, 2008). The two subscales have good internal reliability (Cronbach's alpha = .81 - .85) and the measure has been validated using both student and psychiatric samples (Cardaciotto et al., 2008).

Procedure

Procedures for this study were reviewed and approved by the University of New Mexico Institutional Review Board. All assessments were administered by computer. Participants first gave written informed consent for their participation in the study and then completed a series of assessments beginning with a baseline alcohol Stroop test, the IPI, a 10-minute writing task, and a follow-up Stroop test, followed by the remaining questionnaires (see Figure 1). Participants were randomized to conditions using a block randomization procedure generated by a randomization software package (Saghaei, 2004) to create groups of equal size without stratification for any baseline measures.

Participants first completed an alcohol Stroop test to assess for baseline alcohol-related attentional bias, followed by the IPI. Participants then completed a task in which they wrote about a single target network member listed on the IPI who was perceived as having high general importance and either high or low drinking levels, depending on condition assignment. Only network members with at least moderate importance (i.e., ≥ 3 on the general importance index) were eligible for selection as the target of the writing task, thus removing network members with low importance from eligibility as the target individual in the writing task. Because it is unclear whether network members who are overtly oppositional to the participant's drinking would affect attentional bias differently from network members who simply lack support for drinking, members indicated as being overtly oppositional to the participant's drinking (e.g., left or forced participant to leave when the participant drank) were excluded from eligibility as the target in the writing task. The remaining eligible network members were classified as either heavier or lighter drinkers based on the presence of a positive or negative drinking behavior index, respectively. For participants in the low network drinking condition, the network member with the lowest drinking behavior index among the lighter-drinking network members was selected as the target for a subsequent writing task. For participants in the high network drinking condition, the network member with the highest drinking behavior index among the heavier-drinking network members was selected. Finally, participants had to have listed at least one eligible heavier- and lighter-drinking network member to complete the induction paradigm to maintain balance between groups. If two or more network members had equal scores on the drinking behavior index, the target network member was chosen based on the order the individuals were listed on the IPI, with higher priority for those listed first (See Figure 2 for logic diagram of writing condition assignment).

After the target network member was identified from the IPI, participants completed a writing task with instructions to spend the next 10 minutes writing about the target network member as much as possible, writing down any thoughts that were related to that individual, their qualities, or the participant's relationship to them (adapted from Shipherd & Beck, 2005). Participants were informed that this network member was chosen because the person was rated as being generally important to them. The writing task instructions stated the following:

Among the people in your social network, you identified [network member's name] as a person who is important to you. We would like you to spend the next 10 minutes writing in the text field on the following page whatever information comes to your mind regarding [network member's name]. You may include any information that relates to this person, including shared experiences, feelings, future plans, observations, memories, physical descriptions, your relationship with them, or anything else that comes to mind. Do not worry about spelling or grammar.

Participants whose network structure precluded them from eligibility in the writing task (e.g., having only lighter drinking network members, having only network members of low importance) were not assigned to write about a member of their social network. These participants wrote about a neutral topic (i.e., write about their day) rather than a target network member, with the following instructions:

We would like you to spend the next 10 minutes writing in this text field whatever information comes to your mind about things you have done today. You may include any information that relates to what you have done today, including experiences, feelings, plans made, observations, memories, physical descriptions, relationships, or anything else that comes to mind. Do not worry about spelling or grammar.

Following the writing task, all participants immediately completed a post-task alcohol Stroop test to assess the impact of the task on alcohol-related attentional bias. Following the post-task alcohol Stroop test, participants completed the Timeline Followback questionnaire, Philadelphia Mindfulness Scale, and demographic questionnaires. At the conclusion of the experiment, participants were debriefed about the nature of the study and provided with community and university resources that could offer support if they were concerned about their drinking. A full depiction of participant recruitment, attrition, and randomization is presented in Figure 3.

Data Analysis

Validity checks. A manipulation check assessed the level of participants' engagement in the writing task by asking participants to rate from 1 to 10 the level at which they engaged their thinking toward the selected person throughout the 10-minute task. There were no outliers reporting significantly low levels of engagement (e.g., $z \leq -3$), and no participants were removed from analyses.

To interpret the success of randomization in creating equal groups between conditions, Student's *t*-tests and chi-square tests assessed for equality between groups based on reported demographic information, drinking quantity, support for drinking, social network size, and pre-induction attentional bias. Distributions for each of the variables in the sample were examined for potential confounding issues (e.g., outliers, non-normal distributions, between-group differences at baseline) and dealt with accordingly (e.g., transformation, use of non-parametrical statistical procedures).

Data management. Response latencies from the Stroop test were calculated following methods consistent with previous research (e.g., Fadardi & Cox, 2008) by averaging reaction times within alcohol and neutral category trials. Trials in which unrealistically fast or slow reaction times occurred (i.e., less than 250 ms or greater than 1250 ms) were excluded in accordance with previous studies, as were trials with incorrect color-naming responses. For analyses where a single index of alcohol-related attentional bias was required (e.g., regression analyses), alcohol interference scores were calculated by subtracting mean neutral-word response latencies from mean alcohol-word response latencies.

Hypothesis testing. All statistical tests were conducted using R statistical software (R Core Development Team, 2010) with the exception of the mediation analyses. To test the hypotheses that drinking quantity is related to alcohol-related attentional bias and to network drinking, bivariate correlational analyses were conducted to assess the associations between the mean number of drinks per drinking day and baseline alcohol interference scores on the Stroop test and the percentage of heavy drinkers in the social network. The drinking-related problems index from the RAPI also was used as an additional measure of drinking behavior. Bootstrapping-based mediation analyses were conducted using the methods and SPSS syntax provided by Hayes (2009) to test whether alcohol-related attentional bias had a mediating effect on the relationship between participant drinking and social network drinking.

Group differences in Stroop task performance were examined to test the hypothesis that focusing on heavy versus light drinkers in the social network would differentially affect attentional bias. Several 2 (group) × 2 (stimulus type) mixed ANOVAs were conducted to detect baseline Stroop effects, with drinking level (i.e., high vs. low drinking frequency or intensity, based on median split) as the between-subjects factor and stimulus type (i.e., alcohol vs. neutral word) as the within-subjects factor. Further, 2 (group) × 2 (stimulus type) × 2 (time) × 3 (condition) mixed ANOVAs (with time as a within-subjects factor and condition as a between-subjects factor, with a mean of 14 participants per cell) were conducted to detect changes in attentional bias between the two Stroop test administrations as functions of experimental condition and drinking levels. The presence of a significant three-way interaction for stimulus type × time × condition would indicate that response latencies between alcohol and neutral words differed between group conditions from pretest to posttest, providing evidence for a differential change in attentional bias between groups. A significant four-way interaction would indicate that the effects of the experimental condition were moderated by drinking levels. Significant ANOVA interactions were further explored following the guidelines of Maxwell and Delaney (2004) by probing for significance of subordinate interactions and/or simple effects at each level of the independent variables in the significant interaction.

To test for the moderating effects of mindfulness, Pearson correlational analyses were conducted using baseline alcohol interference scores and percentage of drinking days and mean number of drinks per drinking day to assess the relationship between alcohol attentional bias and drinking behavior. To test acceptance as a moderator in this relationship, a regression analysis on drinking was conducted with alcohol interference scores from the baseline Stroop test and acceptance scores from the Philadelphia Mindfulness Scale entered as Step 1, and the product of the standardized interference and acceptance scores entered as Step 2 (Baron & Kenny, 1986).

Chapter 3

Results

Descriptive and Demographic Information

Fifty-nine of the 84 participants (70%) were female. Thirty participants (36%) reported Hispanic ethnicity, 45 (53%) reported White ethnicity, and 9 (11%) reported other ethnicities. Participants reported consuming alcohol on 26% of days (*SD* = 18%), and reported heavy drinking on 14% of days (*SD* = 13%). On days that drinking occurred, participants reported a mean of 4.47 drinks per drinking day (*SD* = 1.87). Descriptive information for other study measures is presented in Table 2.

Condition Assignment

Forty two participants were randomly assigned to each writing assignment condition upon entrance into the study. Once the condition was assigned, to be eligible to write about a heavy or a light drinking social network member, participants had to have listed at least one heavier drinking and at least one lighter drinking or abstaining network member with at least moderate importance. Fifteen participants did not meet this criterion and were assigned to a third condition to write about the activities they had done during the day. Of these 15 participants, three originally were assigned to write about a light drinking network member and twelve originally were assigned to write about a heavy drinking network member. A chi-square test revealed that significantly more participants originally assigned to write about a heavier drinking network member were assigned to the third condition compared to participants originally assigned to write about a lighter drinking or abstaining network member, $\chi^2(1) = 5.19$, $p = .02$. However, since participants in both conditions had the same criteria for being assigned to the third writing condition (i.e., listing at least one heavier drinking and one lighter drinking or abstaining network member) and were unaware of their condition assignment, there is no reason to believe that this significant difference in assignment was due to condition assignment or any other factor beyond random chance.

There were no significant differences in group assignment for age, $F(2,81) = 0.56$, $p = .57$; percent drinking days (square root transformed), $F(2,81) = 0.46$, $p = .64$; mean drinks per drinking day (square root transformed), $F(2,81) = 0.61$, $p = .55$; gender, $\chi^2(2) = 0.92$, $p = .63$; or ethnicity, $\chi^2(14) = 12.18$, $p = .59$.

Raw Stroop Data

Collapsed across word type, response latencies followed the expected pattern of distribution and are shown in Figure 4. Raw Stroop test response latencies were distributed with a mean of 709 ms (*SD* = 259, *skew* = 1.85, *kurtosis* = 7.86). Cutoff points for acceptable scores were set at 250 and 1250 ms, approximately 2 standard deviations above and below the mean with some adjustment for the positive skew of the distribution. Overall, 94.6% of response latencies were retained after removing incorrect items (3.4% of total responses) and items with response latencies less than 250 ms or greater than 1250 ms (2.2% of the correct responses). The remaining responses were aggregated to compute mean response latencies for each individual for alcohol words (*M* = 672 milliseconds, *SD* = 90) and neutral (*M* = 669, *SD* = 86) words. Mean neutral word response latencies were subtracted from mean alcohol response latencies to determine alcohol interference scores for each individual (*M* = 3.72, *SD* = 37.4). The same procedures and cutoff values were used for the post-writing-task Stroop test to compute mean response latencies for alcohol words (M = 641, SD = 84), neutral words (M = 640, SD = 82), and alcohol interference scores (M = 0.75, SD = 37.3). Baseline alcohol interference scores were normally distributed and are plotted in Figure 5.

Baseline Attentional Bias

To examine the presence of an alcohol-related attentional bias among heavier drinkers, a 2 × 2 mixed ANOVA was conducted on mean response latency with word type (alcohol or neutral) as the within-subjects factor and drinking frequency (lower or higher drinking frequency, based on a median split of percent drinking days) as the between subjects factor. The result showed no significant main effects for word type, $F(1,82) = 0.82$, $p = .37$, or drinking frequency, $F(1,82) = 0.07$, $p = .79$, and no significant word type by drinking frequency interaction, $F(1,82) = 0.61$, $p = .43$. These findings indicate that across the sample, participants did not have greater response latencies for either word type, and reaction times for both word types were unrelated to drinking frequency based on a median split.

A second mixed 2 × 2 ANOVA was conducted on mean response latency with word type (alcohol or neutral) retained as the within-subjects factor, and replacing drinking frequency with drinking intensity (lower or higher drinking intensity, based on a median split of mean drinks per drinking day) as the between subjects factor. The results showed a significant word type by drinking intensity interaction, $F(1,82) = 5.04$, $p = .03$, indicating that participants responded differently to alcohol words compared to neutral words depending on their drinking intensity (see Figure 6). The direction of this interaction effect was opposite of that expected by our hypotheses, with low intensity drinkers having greater response latency to alcohol words than neutral words (i.e., more alcohol-related attentional bias), $F(1,41) = 4.84$, $p = .03$, and high intensity drinkers having no difference in response latencies between word types, $F(1,41) = 0.90$, $p = .35$ (see Figure 6). Results from this ANOVA showed no significant main effects for word type, $F(1,82) = 0.87$, $p = .35$, or drinking intensity, $F(1,82) = 0.41$, $p = .41$.

A third mixed 2 × 2 ANOVA was conducted on mean response latency with word type (alcohol or neutral) retained as the within-subjects factor, and drinking-related problems as a between-subjects factor (lower or higher history of drinking-related problems based on median split of RAPI scores). The results showed a non-significant word type by drinking-related problems interaction, $F(1,82) = 0.004$, $p = .94$, and no significant main effect on response latency for drinking-related problems $F(1,82) = 0.24$, $p = .63$.

To test whether the lack of significant effects was due to a lack of discrepancy in drinking levels created by a median split, two additional 2 × 2 mixed ANOVAs were conducted using only the highest and lowest quartiles for drinking frequency, drinking intensity, and drinking-related problems as between-subjects factors instead of a median split. Results from these ANOVAs failed to find significant effects for drinking-level by word-type interactions based on drinking frequency, $F(1,36) = 0.55$, $p = .46$, and drinking intensity, $F(1,36) = 0.82$, $p = .37$. However, this ANOVA detected a significant drinking-related consequences by word-type interaction, $F(1,42) = 5.36$, $p = .03$. Follow-up contrasts revealed that low problem drinkers did not have a significant difference in response latencies for alcohol (M = 659) and neutral words (M = 652) at baseline, $F(1,22) = 1.26$, $p = .27$, whereas high problem drinkers had significantly shorter response latencies for alcohol words (M = 646) than neutral words (M = 661), $F(1,20) = 4.45$, $p = .047$, contrary to the expected pattern of results.

Bivariate correlation tests were non-significant for baseline Stroop test difference scores with percent drinking days, $r(82) = .07$, $p = .52$ or total number of drinks per week $r(82) = -.07$, $p = .70$. Stroop test difference scores were correlated significantly with drinks per drinking day, but in the opposite direction of what was hypothesized, $r(82) = -.22$, $p = .04$, with longer alcohol-word response latencies associated with lower drinking intensity, similar to the word type × drinking intensity ANOVA above. The correlation between Stroop test difference scores and RAPI scores was marginally significant and in the opposite direction of what was expected, $r(82) = -.19$, $p = .08$, indicating that people experiencing more alcohol-related problems had less attentional bias for alcohol cues. The lack of correspondence in the expected directions between drinking levels and baseline Stroop interference suggests that before any experimental manipulation was administered, drinking frequency and intensity did not correspond with longer response latencies for alcohol cues as expected.

Additional post-hoc analyses were used to further probe for the presence of an attentional bias for alcohol cues in the Stroop test. An ANOVA was conducted to examine the number of incorrect color-naming responses to alcohol and neutral words, where a higher error rate for alcohol words would indicate an attentional bias for alcohol cues. This method for detecting attentional bias is less common than using response latencies but it has been used occasionally to detect attentional bias (e.g., Duka & Townshend, 2004). A 2 × 2 mixed ANOVA for word type (alcohol vs. neutral) and drinking frequency (based on median split) was conducted using the number of incorrect responses on the baseline Stroop test as the dependent variable. This analysis yielded a marginally significant word-type by drinking-frequency interaction, $F(1,82) = 2.96$, $p = .09$, however, the direction of this interaction was in the opposite direction than expected. Lower-frequency drinkers had marginally higher rates of incorrect responding to alcohol words compared to higher-frequency drinkers (see Figure 7), which, contrary to our expectations, suggests that less frequent drinkers exhibited marginally higher error rates for alcohol words than more frequent drinkers. Both main effects for this ANOVA were non-significant for word type, $F(1,82) = 0.37$, $p = .55$, and drinking frequency, $F(1,82) = 1.18$, $p = .28$. A similar 2 × 2 mixed ANOVA with drinking intensity (based on median split) yielded a non-significant word-type by drinking-intensity interaction, $F(1,82) = 1.80$, $p = .18$, and non-significant main effects for word type, $F(1,82) = 0.36$, $p = .55$, and drinking intensity, $F(1,82) = 0.06$, $p = .80$.

Experimental Condition Effects on Attentional Bias

To examine the effects of the writing task on changes in attentional bias, a 2 × 2 × 2 × 3 mixed ANOVA was conducted on mean response latency with word type (alcohol vs. neutral) and time (baseline vs. post-writing-task Stroop) as within-subjects factors, and drinking frequency (lower vs. higher drinking frequency, based on a median split of percent drinking days) and writing task condition (writing about heavy drinker vs. light or abstaining drinker vs. activities during the day) as between subjects factors[1]. Results from this ANOVA are presented in Table 3. Mean response latencies for alcohol and neutral words are plotted by group in Figure 8. All three-way interactions were non-significant, including the word type × condition × Stroop test time interaction, $F(2,78) = 1.15$, $p = .32$, indicating that experimental condition did not invoke changes in Stroop interference. Drinking frequency did not moderate this non-significant three-way interaction, as indicated by a non-significant four-way interaction, $F(2,78) = 0.18$, $p = .83$, indicating that drinking frequency did not play a significant role in this non-significant experimental effect. The mixed ANOVA revealed a significant condition × drinking frequency interaction for overall response latencies, $F(2,78) = 3.47$, $p = .04$, indicating that higher and lower frequency drinkers had different response times between the three conditions when collapsed across word type (alcohol or netural) and Stroop test time (baseline Stroop or post-writing-task Stroop). Since this significant two-way interaction collapses for word type, it does not directly reveal any implications for attentional bias between stimulus types. The 4-way ANOVA also revealed a significant main effect for Stroop test time, $F(1,78) = 36.4$, $p < .001$, indicating that participants had higher overall response latencies for the baseline Stroop test ($M = 670$) than the post-writing-task Stroop test ($M = 640$).

A similar a $2 \times 2 \times 2 \times 3$ mixed ANOVA was conducted using drinking intensity determined by a median split of mean drinks per drinking day as a between subjects factor

[1] Each mixed ANOVA was also tested as a $2 \times 2 \times 2 \times 2$ mixed ANOVA with the third experimental condition (writing about your day) removed. Results from these tests were congruent with the ANOVA

instead of drinking frequency. Results from this ANOVA are presented in Table 4. Mean response latencies for alcohol and neutral words are plotted by group in Figure 9. The omnibus ANOVA revealed a significant three-way word type × Stroop test time × drinking intensity interaction, $F(1,78) = 9.06$, $p = .003$, indicating that participants had different Stroop interference between the two test administrations depending on their drinking intensity. This interaction was not moderated by condition assignment, as indicated by a non-significant four-way word type × Stroop test time × drinking intensity × condition interaction, $F(2,78) = 0.72$, $p = .49$, suggesting this difference between test administrations was not due to the differences between the writing task conditions. The three-way interaction was explored further by collapsing subjects across writing task conditions and examining the two-way word type × Stroop test time interaction at both levels of high and low drinking intensity. Significant two-way interactions were followed with simple effects tests for word type within each level of Stroop test time, and simple effects tests for Stroop test time within each level of word type. New error terms were computed for each follow-up test as this method is robust when error terms are heterogeneous (Maxwell & Delaney, 2004). Follow-up ANOVAs revealed a significant Stroop test time × word type interaction for low intensity drinkers, $F(1,41) = 6.50$, $p = .01$, and a marginally significant Stroop test time × word type interaction for high intensity drinkers, $F(1,41) = 3.47$, $p = .07$. For low intensity drinkers, there was a significant simple effect for word type for the baseline Stroop test, $F = 4.84$, $p = .03$, with longer response latencies for alcohol words than neutral words, and no significant simple effect for word type for the post-writing-task Stroop test, $F(1,41) = 2.05$, $p = .16$. For

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results in the text and are not presented. Adding gender and race to the model as additional factors also did high intensity drinkers, there was no significant simple effect for word type for the baseline Stroop test, $F(1,41) = 0.90$, $p = .35$, and a marginally significant simple effect for word type for the post-writing-task Stroop test, $F(1,41) = 4.04$, $p = .051$, with longer response latencies for alcohol words than neutral words collapsing across condition assignment. This pattern of results suggests that low-intensity drinkers had significantly longer response latencies for alcohol cues for the baseline Stroop test but not for the post-writing-task Stroop test, and that high-intensity drinkers had no significant difference in response latencies for alcohol and neutral cues at baseline but had marginally significantly longer response latencies to alcohol words in the post-writing-task Stroop test. Simple effects tests for Stroop test time (baseline vs. post-writing-task) within each level of drinking intensity and word type were less revealing: all simple effects for test time were significant and indicated a decrease in response latency from baseline to post-writing-task Stroop, indicating that participants increased their responding time between test administrations, which is consistent with the main effect for Stroop test time presented in Table 4.

This omnibus ANOVA also produced a significant main effect for Stroop test time, $F(1,78) = 40.02$, $p < .001$, indicating that participants decreased overall response latencies from the baseline administration to the post-writing-task administration of the Stroop test. Results from this mixed ANOVA also indicated a significant condition × drinking intensity × Stroop test time interaction, $F(2,78) = 4.19$, $p = .02$, indicating that participants had different amounts of change in their overall response latencies

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not significantly impact the results.

(collapsing for word type) from the baseline Stroop test to the post-writing task Stroop test based on a combination of their drinking intensity and condition assignment. Follow-up ANOVAs were conducted separately for participants in each condition, revealing a significant drinking intensity× Stroop test time interaction (collapsing for word type) for participants in the heavy-drinker writing condition, $F(1, 28) = 4.39$, $p = .045$, and a marginally significant drinking intensity× Stroop test time interaction (collapsing for word type) for participants in the light-drinker writing condition, $F(1,37) = 3.60$, $p = .07$. The same interaction was non-significant for participants in the writing condition about the events in their day, $F(1,13) = 0.49$, $p = .49$. Follow-up one-way ANOVAs revealed that participants increased their overall speed of responding only if they had specific combinations of drinking intensities and writing condition assignments. More specifically, low-intensity drinkers in the heavy-drinker writing condition significantly decreased their response latencies from baseline ($M = 674$) to post-test ($M = 627$), $F(1,16) = 27.54$, $p < .001$; and high-intensity drinkers in the light-drinker writing condition also significantly decreased their response latencies from baseline ($M = 674$) to post-test ($M = 627$), $F(1,21) = 23.03$, $p < .001$. However, low-intensity drinkers in the light-drinker writing condition did not significantly change their response latencies from baseline ($M = 659$) to post-test ($M = 641$), $F(1,16) = 1.90$, $p = .19$; high-intensity drinkers in the heavy-drinker writing condition also did not significantly change their response latencies from baseline ($M = 662$) to post-test ($M = 647$), $F(1,12) = 1.54$, $p = .24$. Additionally, high-intensity drinkers in the writing condition about events from their day did not significantly decrease response latencies from baseline ($M = 722$) to post-test ($M = 702$),

$F(1,6) = 2.95$, $p = .14$, nor did low-intensity drinkers (baseline $M = 646$, post-test $M = 639$), $F(1,7) = 0.32$, $p = .59$. However, since this three-way interaction did not include word type (alcohol vs. neutral) as a factor, the results do not imply that any interference was due specifically to alcohol stimuli, and do not directly suggest differential changes in attentional bias based on writing condition or drinking intensity.

A third $2 \times 2 \times 2 \times 3$ mixed ANOVA was conducted using drinking-related problems determined by a median split of RAPI scores as a between subjects factor instead of drinking frequency or intensity. Results from this ANOVA are presented in

Table *5*. All main effects and interactions for this ANOVA were non-significant except for the significant main effect for Stroop test time reported above, providing no indication for experimental activation of attentional bias that would be moderated by experiences of drinking-related problems.

Additional 2 × 2 × 2 × 3 mixed ANOVAs retaining only individuals in the highest and lowest quartiles for either drinking frequency or drinking intensity (mean of 7 participants per cell) also failed to find evidence of an experimental effect on attentional bias. All main effects and interactions for a 2 × 2 × 2 × 3 mixed ANOVA with high or low drinking-frequency quartile as a between subjects factor were non-significant (p-values > .13), except for the main effect of Stroop test time, $F(1,36) = 30.74$, $p < .001$, indicating that participants responded faster in the post-writing-task Stroop test than the baseline Stroop test. In a separate 2 × 2 × 2 × 3 mixed ANOVA with high or low drinking-intensity quartile as a between subjects factor, the previously significant word type × Stroop test time × drinking intensity interaction was reduced to marginal significance, $F(1,36) = 3.39$, $p = .07$, and all other main effects and interactions were non-significant (p-values > .22) with the exception of the significant main effect for Stroop test time.

Further, mixed ANOVAs using the number of incorrect responses as the dependent variable also failed to show evidence of an effect for the experimental condition. A 2 × 2 × 2 × 3 ANOVA with word type and Stroop test time as within subjects factors and drinking frequency (based on median split) and condition as between subjects factors yielded a nonsignificant three-way time × word type × condition interaction, $F(2,78) = 0.10$, $p = .90$, indicating that the experimental condition did not cause a significant change in incorrect responding to alcohol vs. neutral words. Further, this ANOVA also resulted in a non-significant four-way time × word type × drinking frequency × condition interaction, $F(2,78) = 0.94$, $p = .40$, indicating that the experimental condition did not alter attentional bias based on frequency of drinking. A similar 2 × 2 × 2 × 3 ANOVA using drinking intensity (based on median split) instead of drinking frequency also resulted in a non-significant time × word type × condition interaction, $F(2,78) = 0.10$, $p = .90$, and a non-significant time × word type × drinking frequency × condition interaction, $F(2,78) = 0.78$, $p = .46$.

To test the effect of experimental condition in a different way, an ANCOVA was performed on interference scores for the post-writing-task Stroop test predicted by a categorical variable for condition, a continuous variable for baseline Stroop interference scores, and the product[2] of these two predictors. The ANCOVA model resulted in non-significant effects for condition, $F(2,78) = 0.33$, $p = .72$, baseline Stroop interference scores, $F(1,78) = 1.97$, $p = .16$, and the interaction of these two terms, $F(2,78) = 0.54$, $p = .58$. This ANCOVA model is plotted in Figure 10.

Attentional bias as a Mediator for Social Support and Alcohol Consumption

A mediation analysis was conducted to determine whether the relationship between participant-level alcohol consumption and social-network-level drinking was

[2] Traditional ANCOVA does not include the interaction term. The interaction term was included in this model to account for additional error variance and to detect whether changes at the post-test were due to an interaction of baseline attentional bias with experimental condition as well as the main effects of experimental condition.

statistically mediated by alcohol-related attentional bias. Mediation analyses were conducted testing linkages between four IPI indices representing social network drinking behavior (drinking status of network members, drinking frequency of network members, maximum drinking of network members on a drinking day, percentage of heavy drinkers in the network) and two TLFB indices representing participant-level drinking behavior (percentage of drinking days, mean number of drinks per drinking day), acting through the mediating variable of alcohol-related attentional bias (difference scores for the baseline Stroop test). In accordance with the guidelines provided by Hayes (2009), mediation tests were performed using bootstrapping with 1000 iterations for the eight combinations of participant-level and social-network-level alcohol consumption.

Consistent with the non-significant relationship between attentional bias for alcohol cues and drinking, all indirect effects of network-level drinking on participant-level consumption through attentional bias were non-significant, although several social network variables had significant direct effects on participant-level drinking. Results from these mediation analyses are presented in Table 6.

Mindfulness as a Moderator of Attentional Bias and Drinking

Multiple regression analyses were conducted to detect whether the acceptance or awareness components of mindfulness moderated any relationship between baseline attentional bias for alcohol cues and alcohol consumption. Following similar procedures to Ostafin and Marlatt (2008), a regression model was tested with percentage of drinking days (square-root transformed) predicted by baseline alcohol interference scores on the Stroop test at step 1, and the interaction of interference scores and acceptance or awareness (entered as separate analyses) at step 2. Step 1 yielded a non-significant effect of interference scores predicting drinking frequency, $t(82) = 0.64$, $p = .52$. Step 2 produced a non-significant interference score by acceptance interaction to predict drinking frequency, $t(80) = -.97$, $p = .34$, suggesting that acceptance had no significant moderating effect on the relationship between attentional bias and drinking frequency. Similar results were found for awareness as a moderator at step 2, $t(80) = 0.21$, $p = .83$; however awareness had a significant positive main effect on drinking frequency at step 2, $t(80) = 2.58$, $p = .011$, $\beta = .009$.

A similar multiple regression analysis was conducted using drinking intensity (mean drinks per drinking day, square-root transformed) as the dependent variable. Results from this analysis show that alcohol interference scores significantly predicted drinking intensity at step 1, with higher alcohol interference scores predicting fewer drinks per drinking day, $t(82) = -2.06$, $p = .04$, $\beta = -.011$, consistent with the findings presented above and opposite of what the study hypotheses predicted. The interference score by acceptance interaction at step 2 was non-significant, $t(80) = -1.24$, $p = .22$. The interference score by acceptance interaction at step 2 was also non-significant, $t(80) = -.71$, $p = .48$. Results from these analysis failed to find significant moderating effects of awareness and acceptance on the relationship between attentional bias and alcohol consumption; however they do suggest that higher awareness may correspond with heavier drinking episodes.

A 2 × 2 × 2 mixed ANOVA was performed on average response latency with word type (alcohol or neutral) as the within subjects factor and acceptance (low or high based on median split of the PHMS acceptance subscale) and drinking frequency (low or high, based on median split of percent drinking days) as between subjects factors. The presence of a significant three-way interaction would indicate that the correspondence between drinking frequency and attentional bias for alcohol cues (i.e., the drinking frequency × word type interaction) is moderated by acceptance. The three way word type × drinking frequency × acceptance interaction was non-significant, $F = 0.25$, $p = .61$. Similarly, the word type × drinking intensity (based on a median split of mean drinks per drinking day) × acceptance interaction was also non-significant, $F(1, 82) = 0.08$, $p = .78$. Interactions examining the awareness component of mindfulness as a moderator between drinking and alcohol attentional bias were non-significant for the word type × drinking frequency × awareness interaction, $F(1.82) = 0.05$, $p = .82$, and the word type × drinking intensity × awareness interaction, $F(1,82) < 0.01$, $p = .98$.

Lack of Stroop Effect: Further Exploration

As noted above, baseline Stroop test reaction times did not indicate that response latencies for alcohol words and neutral words corresponded with participant drinking levels in the hypothesized directions. Because the literature has consistently reported a positive relationship between drinking and greater reaction times to alcohol words on the Stroop (Bruce & Jones, 2004; Fadardi & Cox, 2008; Johnsen,et al., 1994; Lusher, et al., 2004; Sharma, et al., 2001), baseline Stroop scores were further analyzed for possible explanations or confounds that might explain the divergent findings in the present study.

Range of accepted reaction times. In the preceding analyses, mean response latencies for alcohol and neutral words were computed for correct responses that were greater than 250 ms and less than 1250 ms. The choice to use this range for acceptable response latencies was based on the observed distribution of response latencies, and on the limitations of how short or long a response latency may be with the word meaning still being processed. However, it is possible that using different cutoff points for response latencies (e.g., between 400 and 2000 ms as an acceptable range; Fadardi & Cox, 2008), would result in a different set of findings that are more consistent with the study hypotheses.

To test whether the response latency of 250 and 1250 ms used in the present study could be producing the null findings, mean baseline response latencies were recomputed accepting all correct responses between 400 and 2000 ms. Difference scores using this range for acceptable responses were recomputed and were highly correlated with the original difference scores, $r(82) = .68$, $p < .001$, indicating that the two methods had 46% overlapping variance.

Using the responses from the latency range of 400 to 2000 ms, a 2 × 2 mixed ANOVA on mean baseline response latency with word type (alcohol vs. neutral) and drinking frequency (low vs. high frequency based on a median split of percent drinking days) produced a non-significant interaction, $F(1,82) = 0.867$, $p = .35$. A similar 2 × 2 mixed ANOVA on mean baseline response latency with drinking intensity (low or high drinking intensity based on a median split of mean drinks per drinking day) instead of drinking frequency as the between subjects factor produced a marginally significant two-way interaction, $F(1,82) = 2.99$, $p = .09$. However, as with the same 2 × 2 mixed ANOVA computed using the original range of acceptable cutoff scores, the observed pattern was not in the expected direction, with response latencies for lower intensity drinkers being higher for alcohol words than neutral words, $F(1,41) = 4.85$, $p = .03$, and there being no difference in response latencies between the two word types for high intensity drinkers, $F(1,41) = .25$, $p = .62$.

This pattern of findings suggests that the lack of observed correspondence between drinking and Stroop interference was not due to the range that was selected for acceptable response times.

Color effect for Stroop test. It is possible that a significant Stroop effect that corresponded with alcohol consumption could be present for the stimuli presented in some colors but not others. For example, the yellow words on a white background during the Stroop test may have been harder to read and caused less interference than the other bolder colors or may have caused more interference due to the difficulty in seeing these items and washed out any difference related to word type.

To test whether a Stroop effect was present for some colors but not others, mean response latencies for alcohol and neutral words from the baseline Stroop test were recomputed for each of the four colors presented. A 2 × 2 mixed ANOVA was conducted independently for each color on mean response latencies as the dependent variable, word type (alcohol or neutral) as the within-subjects factor, and drinking frequency (low or high frequency based on a median split of percent drinking days) as the between subjects factor. Two-way interactions were non-significant for each of the four colors: red, $F(1, 82) = 1.97$, $p = .16$; green, $F(1,82) = 0.34$, $p = .56$; yellow, $F(1,82) = .02$, $p = .88$; and blue, $F(1,82) < .01$, $p = .99$, indicating that attentional bias did not correspond with drinking frequency for any of the colors individually. Similar 2 × 2 mixed ANOVAs were conducted using drinking intensity instead of drinking frequency as the between subjects factor. Two-way interactions were non-significant for red, $F(1,82) = 1.11$, $p = .30$; green, $F(1,82) = .26$, $p = .51$; and blue, $F(1,82) = 1.38$, $p = .24$. For yellow words there was a significant two-way interaction in the opposite direction expected by the study hypotheses, $F(1,82) = 6.33$, $p = .01$, in which low intensity drinkers had faster response times for neutral words than alcohol words, $F(1,41) = 6.31$, $p = .02$, and high intensity drinkers did not differ significantly in response times for alcohol words and neutral words, $F(1,41) = 1.50$, $p = .23$. The pattern of results suggests it is unlikely that a Stroop effect was suppressed by any single color, and suggests that the significant baseline Stroop effect for low-intensity drinkers was carried by Stroop words presented in yellow, but not blue, red, or green.

Reliability of Stroop interference scores. It is possible that the differences in mean response latencies of alcohol and neutral words from the Stroop test used in this study were unreliable and that this unreliability contributed to the current null findings. Reliability of alcohol interference scores was assessed in multiple ways. First, reliability was examined by assessing the correlation between baseline and post-writing-task difference scores, producing an estimate that is conceptually similar to a test-retest reliability estimate. The correlation between baseline and post-writing-task alcohol interference scores was nonsignificant, $r(83) = -.16$, $p = .15$, suggesting that interference scores were not stable over time, although it is possible that this instability could be due to the tasks performed between test administrations.

An internal reliability analysis of difference scores was conducted to test the consistency of the differences between alcohol and neutral word response latencies. Because the Stroop test does not contain specific indices or question items, color was used as a convenience category for creating indices within the Stroop test. Mean response latencies were computed for the alcohol and neutral words presented in each color, and Cronbach's alpha was computed for the difference scores of each of these crude "indices" of Stroop interference. A high Cronbach's alpha would suggest that the difference scores computed for each color represent an internally consistent, unitary construct. Correlations between difference scores for each color were low and non-significant (see lower half of Table 7). Cronbach's alpha for the four sets of difference scores was less than zero, $\alpha = -0.19$, indicating that the difference scores for the four sets of colors did not significantly covary with each other and are unlikely to represent a unitary construct. Alpha was re-estimated four times, once with the interference score for each color dropped from the analysis, and remained low for each of the four analyses (see diagonal of Table 7), indicating that no single color was responsible for the low internal reliability. Mean response latencies collapsing across word type were highly consistent between subjects, suggesting that participants tended to respond fairly consistently in terms of overall reaction time relative to each other, regardless of word-color (see upper half of Table 7). These findings suggest participants responded fairly consistently to words presented in the Stroop test, and that the overall internal reliability of the Stroop test interference scores (the dependent variable in this study) was poor when assessed using word color as a convenience grouping factor for creating indices within the Stroop test.

Unlike the Stroop test, the questionnaire measures used within the study appear to have high internal reliability (Rutgers Alcohol Problem Index: Cronbach's $\alpha = .86$, Philadelphia Mindfulness Scale—awareness: $\alpha = .81$, Philadelphia Mindfulness Scale—acceptance: $\alpha = .90$). Because the Timeline Followback questionnaire does not contain specific questions or indices, a crude estimate of internal reliability for the instrument was estimated by computing drinking frequency and drinking intensity for each quartile of the 90-day timeline period. Cronbach's alpha for these four convenience indices suggested high internal reliability for self-reported drinking frequency ($\alpha = .92$) and intensity ($\alpha = .86$).

Chapter 4

Discussion

The present study aimed to bridge two well-established factors that may contribute to the frequency and intensity with which individuals drink. Namely, we aimed to examine ways in which alcohol-related attentional bias and social support for drinking may interact with each other. Alcohol-related attentional bias has been shown to predict drinking levels for student and community samples (Bruce & Jones, 2004; Fadardi & Cox, 2008; Johnsen et al., 1994; Lusher et al., 2004; Sharma et al., 2001), and attentional bias for alcohol cues may be increased by exposure to alcohol (Duka & Townshend, 2004) or alcohol-related cues (Cox et al., 1999). Because it is possible that heavier drinking social network members may themselves serve as cues for alcohol use, the present study hypothesized that a writing task that focused on heavier drinking network members would produce an increase in alcohol-related attentional bias compared to a writing task focused on lighter drinking or abstaining network members or a writing task about the events that occurred during your day. When operationalizing attentional bias by performance on an alcohol Stroop test, the results from the present study failed to find an association between higher drinking frequency or drinking intensity and longer response latencies for alcohol words during a baseline alcohol Stroop test. Additionally, the present study failed to find a significant increase in attentional bias based on writing-assignment condition. Contrary to study hypotheses, lower-intensity drinkers were found to have significantly longer response latencies for alcohol words than neutral words during the baseline Stroop test and no significant difference in response latencies for the post-writing-task Stroop test. With attentional bias operationalized as longer response latencies for alcohol words, these results can be interpreted to suggest that lower-intensity drinkers had a greater attentional bias for alcohol at baseline that disappeared after completing the IPI and the writing task, regardless of which writing task they completed. For high intensity drinkers, no significant differences in response latencies were found for word type in the baseline Stroop test, but response latencies for alcohol words were significantly longer compared to neutral word response latencies in the post-writing-task Stroop test, suggesting that higher-intensity drinkers had no attentional bias for alcohol cues at baseline, but their attentional bias for alcohol cues emerged after completion of the IPI and the writing task. Baseline alcohol interference scores did not mediate or have indirect effects on the relationship between participant drinking and social network support for drinking, as would be expected based on the lack of correspondence between interference scores and participant drinking. The awareness and acceptance components of mindfulness did not have moderating effects on the relationship between Stroop interference and drinking frequency or intensity.

Overall, the present study failed to find the expected correspondence between participant drinking levels and biases in response latencies to alcohol words. At times an effect was present but in the opposite direction of what was expected. Examination of the frequency of incorrect responses to the Stroop test and the range of response latencies for all words looks typical compared to other studies, and the overall response latencies (collapsing for word type) are highly consistent within subjects, suggesting that participants' responded in a normal manner and that the DMDX software correctly recorded response latency data. The participant-level summary variables from the Stroop test were extracted from the item responses in multiple ways in an effort to detect the hypothesized effect, using different methods for operationalizing attentional bias (i.e., mean response latency and the number of incorrect responses) and different ranges for acceptable response latencies (i.e., 250 to 1250 ms and 400 to 2000 ms), yet none of these methods for extracting participant-level dependent variables yielded the expected correspondence between attentional bias and drinking levels. Additionally, the expected correspondence was not found when a Stroop effect was examined for each color in the Stroop test. Attentional bias was assessed at two time points, and longer response latencies for alcohol words at both time points generally failed to correspond with drinking levels as expected. Data analysis was conducted from both continuous (i.e., regression) and categorical (i.e., ANOVA) frameworks, and both frameworks generally failed to find the expected relationships.

Further probing of the Stroop test difference scores provided consistent evidence that the alcohol Stroop test may have poor reliability, which may be a key factor in the failure to reject the null hypotheses of the present study. The poor reliability of the alcohol Stroop test used in the present study are in line with previous findings of poor reliability for difference scores in the emotional Stroop test, despite the emotional Stroop test having good reliability for overall response latencies across word types (Eide, Kemp, Silberstein, Nathan, & Stough, 2002). Internal reliability was tested by creating convenience indices for the Stroop test difference scores by computing difference scores for each of the four color categories within the task, resulting in a low Cronbach's alpha statistic, suggesting poor internal reliability. The correspondence between difference scores for the baseline Stroop test and the post-writing-task Stroop test was also low, suggesting poor temporal reliability for the Stroop. The overall poor reliability of the Stroop test interference scores suggests that the alcohol Stroop test may not consistently measure alcohol-related attentional bias. Poor reliability inherently increases error variance, and high error variance can lead to inaccurate measurement and decreased power. Thus, it is likely that the poor reliability of alcohol Stroop interference scores plays some part in the null findings of the present study. However, caution is warranted in generalizing these results for the reliability of the alcohol Stroop test, as the present study was not designed to assess the internal and test-retest reliability of the alcohol Stroop test. The internal reliability analysis in the present study merely used convenience indices to assess internal reliability, and the test-retest reliability may be affected by the other study procedures (i.e., the IPI questionnaire and the writing task) that occurred between Stroop test administrations.

Nonetheless, the present study found that high-intensity drinkers had significantly greater alcohol-word interference during the post-writing-task Stroop test regardless of their condition assignment, and that low-intensity drinkers had significantly greater alcohol-word interference during the baseline Stroop test. Regarding the former finding, one possible explanation is that a common procedure administered before the post-writing-task Stroop test primed participants to have longer response latencies for alcohol words. For example, it is possible that questions about support for drinking and drinking behavior of social network members provided alcohol cue primes before the second Stroop task, whereas subjects were not exposed to alcohol primes before the baseline Stroop test (i.e., very few references to alcohol were included in the screening and consenting process). Previous literature has shown that alcohol-related attentional bias is affected by primes with alcohol (Duka & Townshend, 2004) and alcohol-related cues (Cox et al., 1999); it is possible that participants were primed before the second Stroop test and that high intensity drinkers had a stronger response to these primes in terms of their Stroop interference. However, this inference cannot be tested directly without further experimentation. It is also possible that this effect is a Type I error, and it should be noted that the effect was only marginally significant (p = .051).

Regarding the low intensity drinkers' tendency to have longer response latencies for alcohol words than neutral words during the baseline Stroop test, one possibility is that this unexpected effect is a statistical artifact due to random noise variance. Alternatively, it may be possible that people with less drinking experience were less familiar with the alcohol words presented on the screen than the neutral words. Information processing models of alcohol-related cognition (Albery et al., 2006) posit that both the word meaning and the word color provide competing information in the alcohol Stroop test, and processing of one piece of information interferes with the processing of the other. It is possible that response latencies for alcohol words in the Stroop test have a curvilinear relationship with drinking, where chronically heavy-drinking community members require more processing time for highly-salient alcohol words; low-intensity drinkers, who presumably have less experience with alcohol use, also require more time to process the semantic meaning of the less familiar alcohol-words; and moderately-heavy but non-chronic drinkers require less time to process the familiar, but less emotionally salient alcohol words. However, this explanation is merely inferential and further work is necessary to test why low intensity drinkers may respond more slowly to alcohol words at baseline.

Additionally, the present study detected that low-intensity drinkers in the heavy-drinker writing task and high-intensity drinkers in the light-drinker writing task significantly increased their overall speed of responding by about 47 ms from baseline Stroop to post-writing-task Stroop when collapsing for word type. Alternatively, high-intensity drinkers in the heavy-drinker writing task and low-intensity drinkers in the light-drinker writing task only increased their overall speed of responding by about 15-18 ms, and this effect was non-significant. This interaction was not predicted by the hypotheses of the present study, but this pattern of results suggests that participants showed less improvement in color-naming when they wrote about network members with drinking habits similar to their own. It is possible that this effect may be explained in terms of general distraction within the Stroop test that is unrelated to the type of stimulus displayed (alcohol or neutral words). That is, attending to a person whose drinking habits are very similar to one's own drinking may cause more distraction than attending to a person whose drinking habits are very different, and this distraction may persist regardless of the type of stimuli presented. For example, it is possible that attending to a person with similar drinking habits may divert attention away from the study task and toward shared activities (related or unrelated to drinking) between the two individuals, causing general distraction from the task and slowed responding regardless of stimulus type. This three-way interaction was unexpected and should be replicated before these results are generalized.

Alternatively, the unexpected findings in the present study may be due to an inability to detect attentional bias with randomized presentation of alcohol and neutral words due to carryover effects. In other words, because of the preponderance of alcohol words presented throughout the Stroop test, it is possible that participants who attend strongly to alcohol words have slowed response latencies for all the words in the task regardless of their valence, since most neutrally valanced words were likely to have been preceded by an alcohol word by a few seconds due to the unblocked, random order of stimulus presentation. In this case, the heavy loading of alcohol words in the Stroop task would cause slowed responding for all words, regardless of valence because the overall

Stroop task itself is distracting for those who attend more strongly to alcohol cues. Further experimentation with blocked and unblocked ordering of stimulus presentation or different attentional bias tasks may help explain this finding.

Another reason for the present study's null findings may be related to the sample selected for participation. The present study used university students who reported at least one binge drinking episode within the previous 30 days. Most studies linking alcohol consumption with longer response latencies for alcohol words in the Stroop test have used samples consisting of community drinkers with severe alcohol problems compared to normal community or university samples (e.g., Johnsen et al., 1994; Lusher et al., 2004; Sharma et al., 2001). At least two studies have detected alcohol Stroop effects with college students (Bruce & Jones, 2004; Fadardi & Cox, 2008); however slight differences exist in study procedures between those studies and the present study. For example, Fadardi and Cox (2008) recruited 84 university students and found a significant correspondence between longer mean response latencies for alcohol words and higher drinking frequency, but the Stroop test used in their study included alcohol and neutral words as well as color-congruent words (e.g., the word "red" printed in red font) and color-incongruent words (e.g., the word "blue" printed in red font). Even though response latencies for color-congruent and color-incongruent words were not used in the analyses to test for attentional bias, their inclusion may have created interference in responding to the font color of alcohol and neutral words. Participants in the Fadardi and Cox study also knew about the study's alcohol-related nature and were asked to abstain from drinking for the 24 hours prior to the study, whereas participants in the present study were intentionally kept unaware of the study's alcohol-related nature and were not asked to abstain from drinking. Bruce and Jones (2004) recruited 40 university students, faculty, and staff and also found evidence for longer response latencies for alcohol cues than neutral cues in participants with higher overall drinking quantity (number of drinks per week), but they used a Stroop test consisting of alcohol-related and neutral images rather than text.

Cognitive functioning has been shown to moderate the relationship between attentional bias and alcohol consumption, which may affect detection of attentional bias in college samples. Previous work (Loeber et al., 2009; Thush et al., 2008) has shown that individuals with lower cognitive functioning have stronger relationships between attentional bias and alcohol consumption, and individuals with higher cognitive functioning have weaker relationships between attentional bias and alcohol consumption. Thus, university student samples, which typically do not have high rates of cognitive impairment, may have weaker correspondences between alcohol consumption and attentional bias indices. Although some studies have found a Stroop effect with college students, it is possible that there is "a real file drawer problem with the alcohol Stroop, particularly when looking at non-dependent populations" (Field, personal communication, July 15, 2010).

Overall, the link between alcohol-related attentional bias and drinking is not well established among college students, and the ability to detect significant effects may have been suppressed by key differences between the methods of the present study and the methods of previous studies using the alcohol Stroop test with college students (e.g., informing students of the alcohol-related nature of the study, using color-congruent and color-incongruent words, and using pictures instead of words).

Future work may continue to investigate the correspondence between college student drinking and alcohol-word interference in the Stroop test by incorporating additional methodological considerations. For example, because the alcohol Stroop test requires participants to name word colors, including goal-related semantic cues within the task, such as color-congruent and color-incongruent words, may increase semantic processing of word meanings for color words that also carries over into alcohol and neutral words, potentially increasing the amount of alcohol-related interference and increasing power to detect significant relationships. Using this method, examination of the color-incongruent response latencies compared to color-congruent responses may provide an additional index of how much the participants are actually processing the word meaning within the task. Methodological studies should also evaluate the strengths of blocking stimulus presentation by word category compared to presenting stimuli in a randomized order to reduce possible carryover effects that are present when stimulus order is fully randomized. Similar to the current findings, previous work using variants of the emotional Stroop test, in which participants respond to neutral and depression- and anxiety-related words, have found good test-retest reliability for overall mean response latencies but poor test-retest reliability for difference scores when words were presented in a randomized, unblocked order (Strauss, Allen, Jorgensen, & Cramer, 2005). Methodological studies testing carryover effects in the emotional Stroop test have found that the presentation of depression- and anxiety-related words causes delayed responding to subsequent neutrally valanced words, providing evidence for carryover effects that could inhibit the ability to detect attentional bias in randomized, unblocked designs (Frings, Englert, Wentura, & Bermeitinger, 2010; McKenna and Sharma, 2004). A meta-analysis of emotional Stroop tests found the strongest interference in studies that used blocked rather than randomized presentation ordering (Phaf & Kan, 2007). Carryover effects in depression- and anxiety-related emotional Stroop tests have been attributed to a slow, generalized disengagement response to emotion-related stimuli rather than a fast-acting automatic bias toward the stimuli (Frings et al., 2010; McKenna et al., 2004; Phaf & Kan, 2007); however, these processes of responding in alcohol Stroop tests are less understood (see Cox et al., 2006 for a review). Alcohol Stroop tests have employed a variety of methods for stimulus presentation, including blocked and unblocked presentation order (Cox et al., 2006), and further empirical research on the strengths and weaknesses of each method is warranted to improve theoretical understanding of alcohol-related cognition and to improve the ability to generalize findings across studies (Cox, Pothos, Johnsen, & Laberg, 2001). Previous studies have found more effects with blocked presentation compared to random presentation for a smoking-related Stroop test for nicotine-dependent adults (Waters & Feyerabend, 2000) and for a heroin-related Stroop test for heroin-dependent adults (Waters, Sayette, Franken, & Schwartz, 2005), but further work is necessary to generalize these findings to alcohol Stroop tests with non-dependent student populations.

Although the alcohol Stroop test is one of the most common methods for assessing alcohol-related attentional bias, future works may incorporate other methods for assessing attentional bias, such as dot probe tasks or rapid serial visual presentation tasks, or may take advantage of eye-tracking technology to better detect attentional biases. To the author's awareness, there are currently no published reviews or meta-analyses describing the appropriateness of various tasks for assessing alcohol-related attentional bias with different samples or assessments of their reliability.

Future work should continue to assess the effects of social networks on implicit alcohol-related cognition. Recent work on automatic processes and regulation of goal achievement suggests that people spontaneously and automatically adopt the goals of others (Chartrand, Dalton, & Fitzsimons, 2007), including goals related to substance use (Leander, Shah, & Chartrand, 2009). For example, similar to the goals of the present study, Leander et al. found that subliminal priming of a marijuana user in a person's social network increases that person's desire to use marijuana as measured by implicit and explicit indices. Leander et al. further found that the priming effect was moderated by relational closeness between the participant and the network member, and that the priming effect was also moderated by self regulation (a construct similar to the awareness component of mindfulness). This emerging work suggests that individuals who are associated with substance use may cause individuals in their social network to have an increased desire to use substances, and further exploration is warranted. The findings of Leander et al. suggest that the hypotheses proposed in this study are appropriate and worth further examination, perhaps with alternative measures of assessing alcohol-related attentional bias or desire to consume alcohol.

The null findings of the present study present interesting implications for use of the alcohol Stroop test with college samples. Only a few publications have found significant relationships between drinking and Stroop effects in college students, and it is possible that the consistency of this effect is exaggerated in the published literature due to unpublished null findings. Additionally, the longer response latencies for alcohol words in the low intensity drinking group at baseline provide an interesting contradiction of the extant literature on attentional bias, and further exploration is warranted to examine the stability of this effect and to provide a parsimonious theoretical explanation if it is replicated. The mindfulness component for awareness also had an interesting relationship with drinking frequency, where higher levels of awareness corresponded with more frequent drinking. While this finding replicates the work of others who have found a similar association (Leigh, Bowen, & Marlatt, 2005; Leigh & Neighbors, 2009), this association is poorly understood. Leigh and Neighbors, for example, speculate that these two constructs may be related due to enhancement motives, where people with higher mind-body awareness may be more attuned to feel the positive effects of alcohol use. Replication of this finding in an ethnically diverse sample further supports the relationship between awareness and drinking frequency, and warrants future work aimed at better understanding the underlying mechanisms supporting this relationship.

Future work testing the temporal and internal reliability of the Stroop test and other measures of alcohol-related attentional bias is warranted. Analyses from the present study suggest that the Stroop test may have had poor internal and temporal reliability with the current sample, however because the study was not designed to test the reliability of the Stroop, these inferences regarding its reliability should not be generalized. Future work may also aim to establish more comprehensive guidelines and normative data for measures of alcohol-related attentional bias with a variety of samples.

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Table 1

Words Presented in Alcohol Stroop Test

Alcohol Words	Neutral Words
Cocktails	Sandals
Gin	Necktie
Rum	Vest
Shooters	Shirts
Keg	Sock
Beer	Pants
Beverage	Scarf
Wine	Boot
Liquor	Blazer
Champagne	Mittens
Cooler	Shorts
Mickey	Nylons
Drafts	Shoe
Whiskey	Bathrobe
Alcohol	Overalls
Scotch	Parka
Vodka	Jeans
Rye	Garter

Table 1 (cont.)

Corkscrew	Overcoat
Cider	Smock

Note: Word list reproduced from Birch et al. (2008).

Table 2

Demographic Data Means (SD).

	Full sample (*N* = 84)	Drinking intensity median split		Drinking frequency median split	
		Low intensity (*n* = 42)	High intensity (*n* = 42)	Low frequency (*n* = 42)	High frequency (*n* = 42)
Age	21.12 (4.45)	21.64 (4.44)	20.59 (4.38)	20.76 (4.45)	21.48 (4.41)
%Racial Minority	46.4	40.4	52.4	52.4	40.4
%Women	69.0	83.3	57.1	74.8	66.7
Percentage drinking days	0.26 (0.18)	0.27 (0.20)	0.25 (0.16)	0.11 (0.06)	0.40 (0.14)
Percentage heavy drinking days	0.14 (0.13)	0.08 (0.09)	0.21 (0.13)	0.07 (0.06)	0.21 (0.14)
Drinks per drinking day	4.47 (1.87)	2.96 (0.74)	5.99 (1.35)	4.47 (1.63)	4.47 (2.08)
RAPI total score	13.08 (9.66)	10.67 (9.16)	15.50 (9.54)	10.89 (9.80)	15.29 (8.99)
PHMS awareness	38.04 (5.83)	38.05 (6.69)	38.02 (4.89)	36.07 (6.45)	40.00 (4.39)
PHMS acceptance	29.37 (7.72)	28.90 (7.82)	29.83 (7.58)	30.29 (7.18)	28.45 (8.11)
IPI1 (network size)	3.04 (0.52)	3.01 (0.52)	3.07 (0.52)	3.01 (0.53)	3.08 (0.51)
IPI2 (contact with network)	2.82 (1.71)	2.83 (1.71)	2.81 (1.70)	2.9 (1.55)	2.74 (1.85)
IPI3 (average network importance)	5.82 (0.37)	5.8 (0.42)	5.84 (0.31)	5.88 (0.32)	5.75 (0.40)
IPI4 (network drinking status)	12.45 (3.71)	12.12 (3.45)	12.72 (3.93)	11.81 (3.37)	13.08 (3.92)
IPI5 (network drinking frequency)	0.33 (0.15)	0.32 (0.15)	0.34 (0.14)	0.29 (0.14)	0.37 (0.14)
IPI6 (max drinking of network)	0.28 (0.14)	0.25 (0.13)	0.3 (0.15)	0.26 (0.13)	0.30 (0.15)
IPI7 (heavy drinkers in network)	0.11 (0.15)	0.07 (0.11)	0.15 (0.17)	0.10 (0.12)	0.13 (0.17)
IPI8 (abstainers in network)	0.2 (0.21)	0.2 (0.20)	0.2 (0.22)	0.24 (0.23)	0.15 (0.18)
IPI9 (most support for drinking)	5.58 (0.61)	5.45 (0.63)	5.71 (0.55)	5.5 (0.63)	5.67 (0.57)
IPI10 (least support for drinking)	3.1 (1.23)	3.12 (1.17)	3.07 (1.29)	2.71 (1.10)	3.47 (1.23)
IPI11 (average support for drinking)	0.91 (.26)	0.88 (0.25)	0.94 (0.26)	0.83 (0.24)	0.99 (0.24)

Note: RAPI = Rutgers Alcohol Problem Index, PHMS = Philadelphia Mindfulness Scale, IPI = Important People Inventory.

Table 3

Response Latency ANOVA Results by Stroop Test Time, Word Type, Condition, and Drinking Frequency Median Split.

	df	*SS*	*MS*	*F*	*p*
Error: Subject					
Condition	2	27991	13996	0.5598	.57
Drinking frequency	1	619	619	0.0248	.88
Condition × Drinking frequency	2	173675	86837	3.4735	.04*
Residuals	78	1950010	25000		
Error: Subject × Stroop test time					
Stroop test time	1	76324	76324	36.42	<.001***
Stroop test time × Condition	2	5587	2794	1.33	.27
Stroop test time × Drinking frequency	1	152	152	0.07	.79
Stroop test time × Condition × Drinking frequency	2	1586	793	0.38	.69
Residuals	78	163452	2096		
Error: Subject × Word type					
Word type	1	420	420	0.68	.41
Word type × Condition	2	30	15	0.02	.98
Word type × Drinking frequency	1	267	267	0.43	.51
Word type × Condition × Drinking frequency	2	270	135	0.22	.80
Residuals	78	48332	620		
Error: Subject × Stroop test time × Word type					
Stroop test time × Word type	1	184	184	0.23	.63
Stroop test time × Word type × condition	2	1851	926	1.15	.32
Stroop test time × Word type × Drinking frequency	1	1995	1995	2.48	.12

Table 3 (cont.)

Stroop test time × Word type × Condition × Drinking frequency	2	294	147	0.18	.83
Residuals	78	62731	804		

Note: * $p < .05$. *** $p < .001$.

Table 4

Response Latency ANOVA Results by Stroop Test Time, Word Type, Condition, and Drinking Intensity Median Split.

	df	*SS*	*MS*	*F*	*p*
Error: Subject					
Condition	2	27991	13996	0.53	.59
Drinking intensity	1	16448	16448	0.63	.43
Condition × Drinking intensity	2	55558	27779	1.06	.35
Residual	78	2052298	26312		
Error: Subject × Stroop test time					
Stroop test time	1	76324	76324	40.02	<.001***
Stroop test time × Condition	2	5587	2794	1.46	.24
Stroop test time × Drinking intensity	1	465	465	0.24	.62
Stroop test time × Condition × Drinking intensity	2	15982	7991	4.19	0.019 *
Residual	78	148743	1907		
Error: Subject × Word type					
Word type	1	420	420	0.68	.41
Word type × Condition	2	30	15	0.02	.98
Word type × Drinking intensity	1	8	8	0.01	.91
Word type × Condition × Drinking intensity	2	420	210	0.34	0.71
Residual	78	48441	621		
Error: Subject × Stroop test time × Word type					
Stroop test time × Word type	1	184	184	0.25	.62
Stroop test time × Word type × Condition	2	1851	926	1.26	.29
Stroop test time × Word type × Drinking intensity	1	6659	6659	9.06	.003**
Stroop test time × Word type × Condition × Drinking intensity	2	1063	532	0.72	.49
Residual	78	57298	735		

Note: * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 5

Response Latency ANOVA Results by Stroop Test Time, Word Type, Condition, and Drinking-related Problems Median Split.

	df	*SS*	*MS*	*F*	*p*
Error: Subject					
RAPI	1	16825	16825	0.66	.42
Condition	2	29436	14718	0.58	.56
RAPI × Condition	2	117873	58937	2.31	.11
Residual	78	1988162	25489		
Error: Subject ×Word type					
Word type	1	420	420	0.68	.41
Word type × RAPI	1	3	3	0.01	.94
Word type × Condition	2	30	15	0.02	.98
Word type× RAPI × Condition	2	705	352	0.57	.57
Residual	78	48162	617		
Error: Subject ×Stroop test time					
Stroop test time	1	76324	76324 3	7.71	< .001***
Stroop test time × RAPI	1	2032	2032	1.00	.32
Stroop test time × Condition	2	5807	2904	1.43	.24
Stroop test time × Condition × RAPI	2	5058	2529	1.25	.29
Residual	78	157879	2024		
Error: Subject ×Stroop test time × Word type					
Stroop test time × Word type	1	184	184	0.23	.63
Stroop test time × Word type × RAPI	1	18	18	0.02	.88
Stroop test time × Word type × Condition	2	1848	924	1.15	.32
Stroop test time × Word type × RAPI × Condition	2	2533	1266	1.58	.21
Residual	78	62472	801		

Note: *** $p < .001$.

Table 6

Mediation Results for Network Drinking and Participant Drinking Through Alcohol-related Attentional Bias.

					95% Confidence Interval for Indirect Effect	
	a	b	c	c'	Lower	Upper
IPI4 → Stroop → %DD	0.57	0.0004	0.009+	0.009+	-0.0005	0.0023
IPI5 → Stroop → %DD	16.55	0.0004	0.391**	0.385**	-0.0091	0.067
IPI6 → Stroop → %DD	-6.61	0.0005	0.272+	0.275*	-0.0585	0.0227
IPI7 → Stroop → %DD	4.97	0.0004	0.291*	0.289*	-0.0245	0.0658
IPI4 → Stroop → DpDD	0.57	-0.0006	0.013*	0.013*	-0.0032	0.0006
IPI5 → Stroop → DpDD	16.55	-0.0006	0.421**	0.431***	-0.0809	0.0141
IPI6 → Stroop → DpDD	-6.61	-0.0005	0.392**	0.389**	-0.018	0.0635
IPI7 → Stroop → DpDD	4.97	-0.0006	0.466***	0.469***	-0.0718	0.0344

Note: Arrows indicate mediation path as follows: X → M → Y, where M mediates the relationship between X and Y.   a = X → M path, b = M → Y path, c = X → Y path, c' =

Table 6 (cont.)

X → Y path controlling for M. IPI4 = drinking status of network members, IPI5 = drinking frequency of network members, IPI6 = maximum drinking of network members on a drinking day, IPI7 = percentage of heavy drinkers in the network, Stroop = alcohol interference scores for baseline Stroop test, %DD = percent drinking days of participants, DpDD = mean drinks per drinking day of participants. + $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 7

Correlations of Stroop Test Mean Response Latencies and Alcohol Interference Scores by Color and Cronbach's Alpha with Each Color Removed.

	Red	Green	Yellow	Blue
Red	*.08*	.75***	.71***	.74***
Green	-.28**	-*.35*	.68***	.75***
Yellow	.10	.09	-*.22*	.73***
Blue	-.15	.15	-.15	-*.10*

Note: Diagonals represent estimated alpha reliability for the remaining three subscales if that color is dropped. Correlations for average response latencies by color, collapsing for word type, are presented above the diagonal. Correlations for average alcohol interference scores by color are presented below the diagonal. Overall Cronbach's alpha = -0.19. ** $p < .01$. *** $p < .001$.

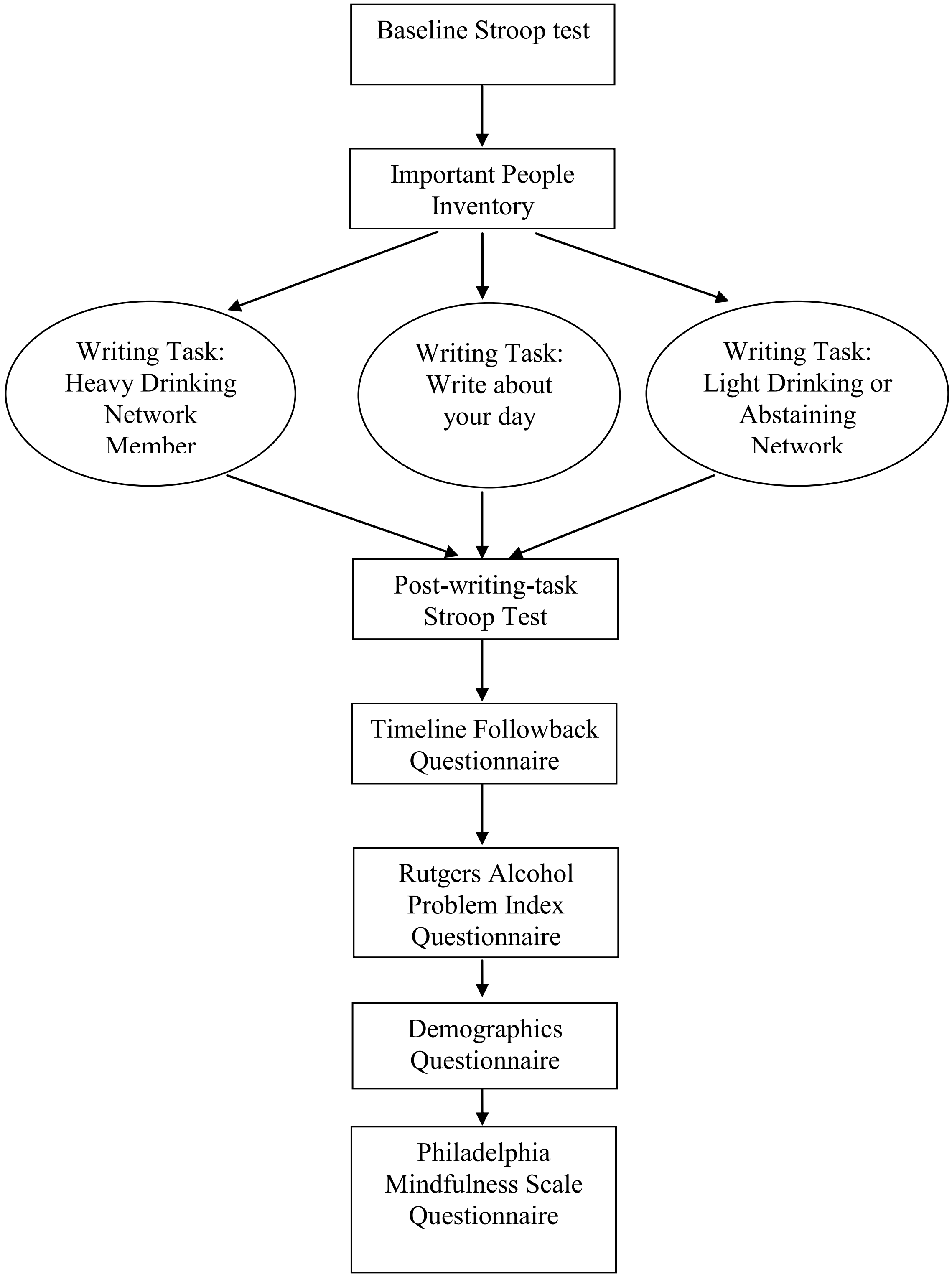


Figure 1. Procedural design.

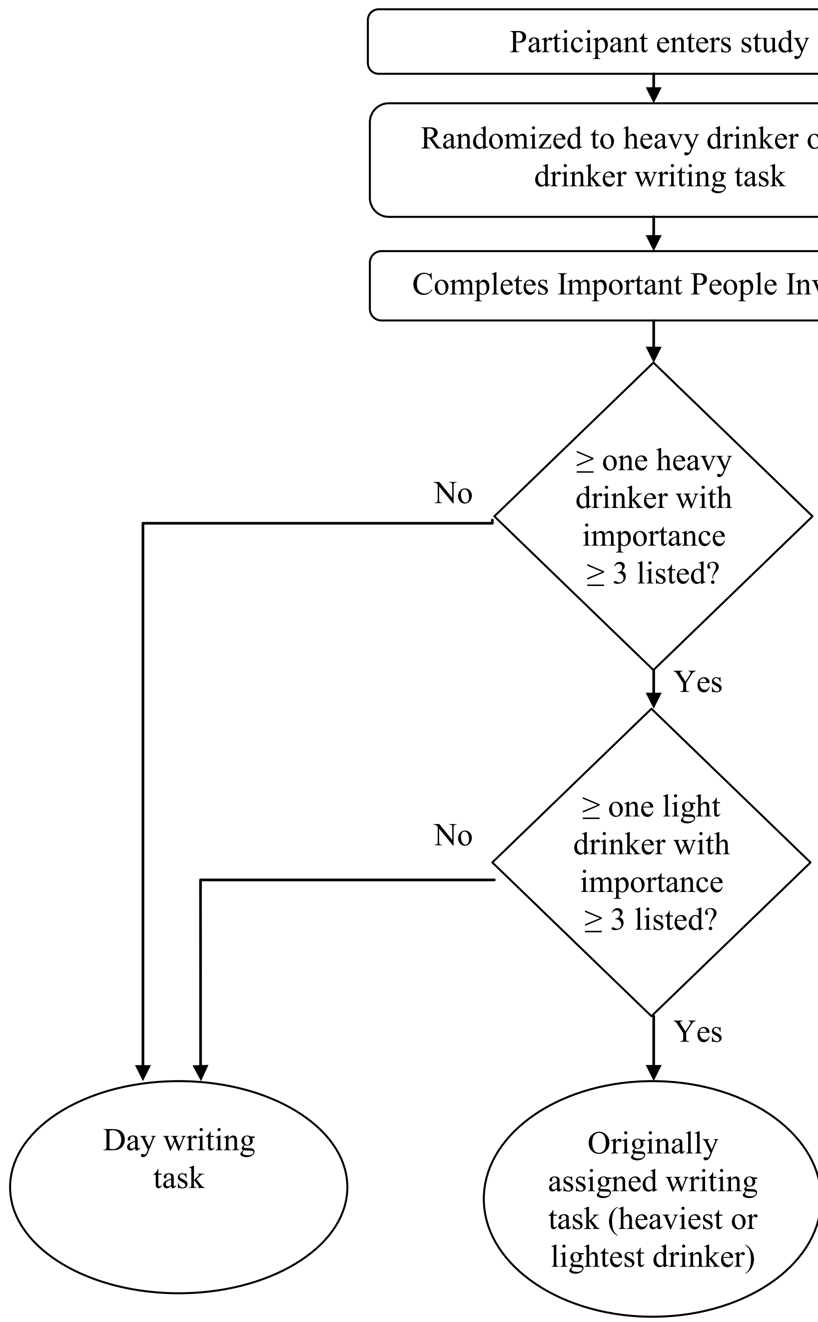


Figure 2. Logic diagram for condition assignment in writing task.

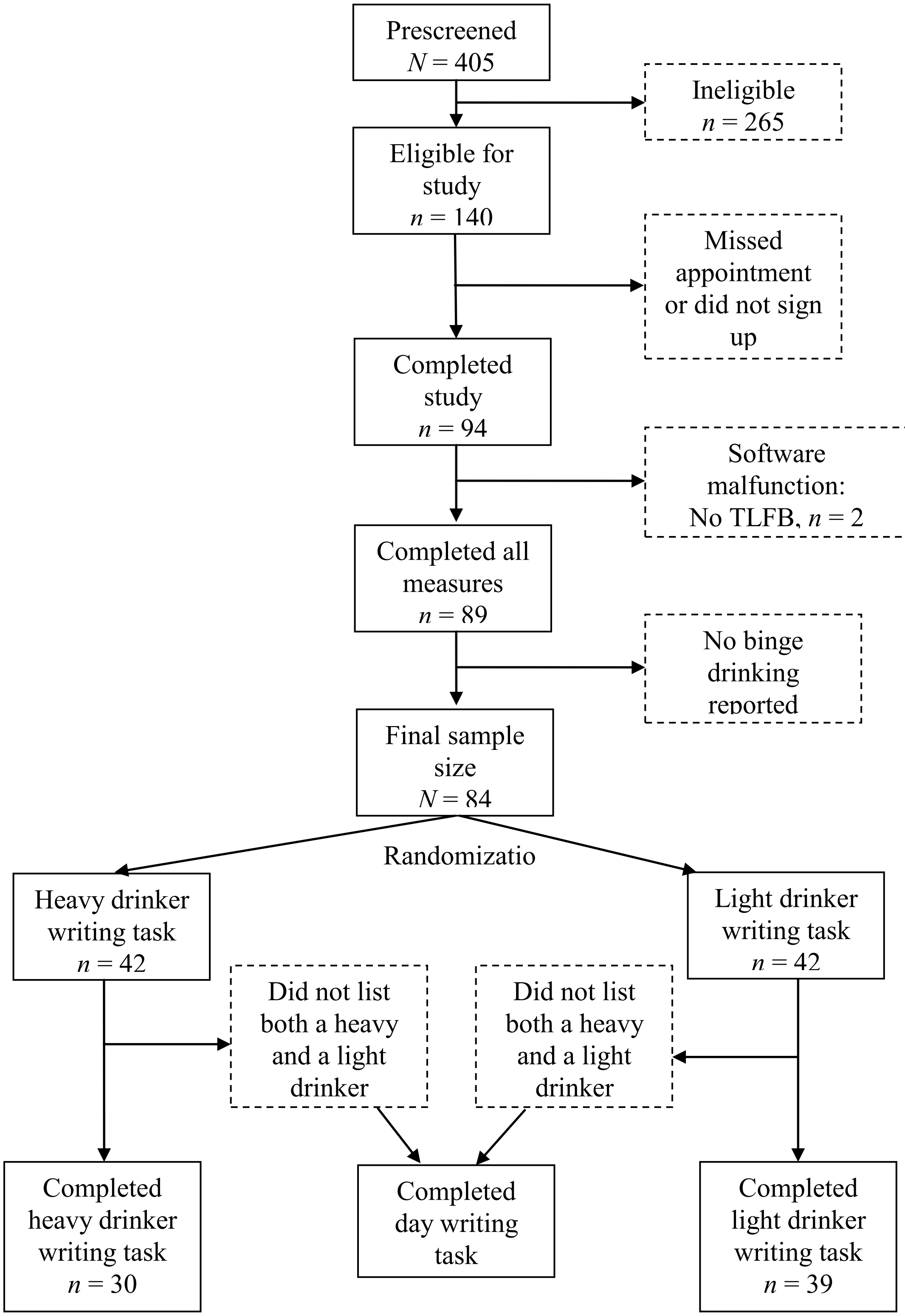


Figure 3. Participant recruitment, attrition, and randomization.

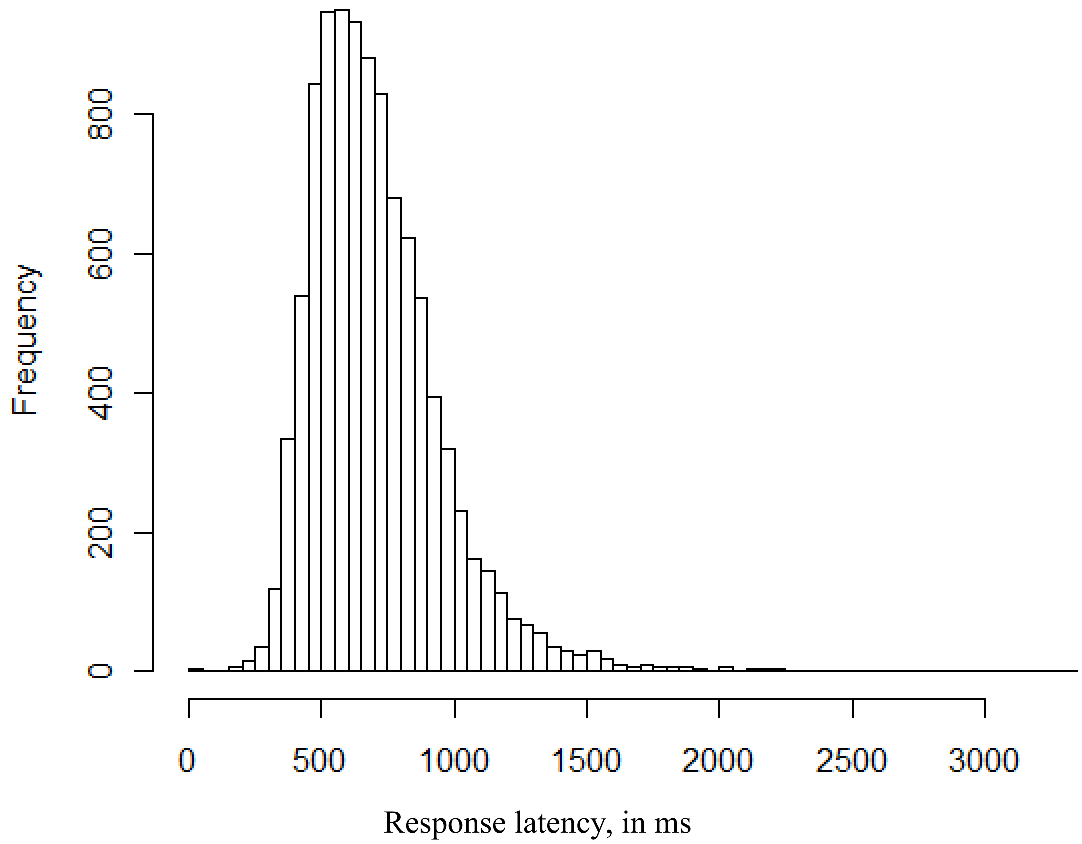


Figure 4. Raw response latencies for baseline Stroop test for all word types.

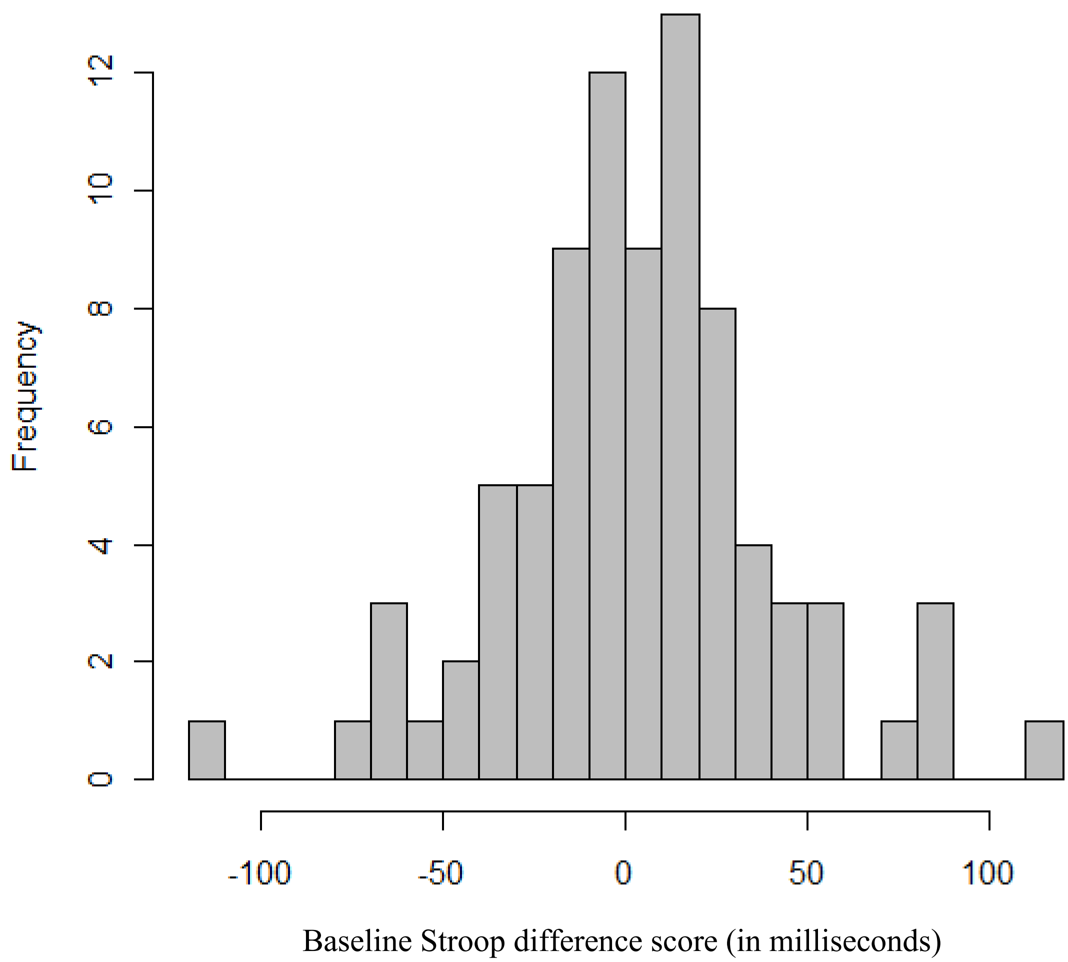


Figure 5. Histogram of baseline alcohol Stroop test difference scores.

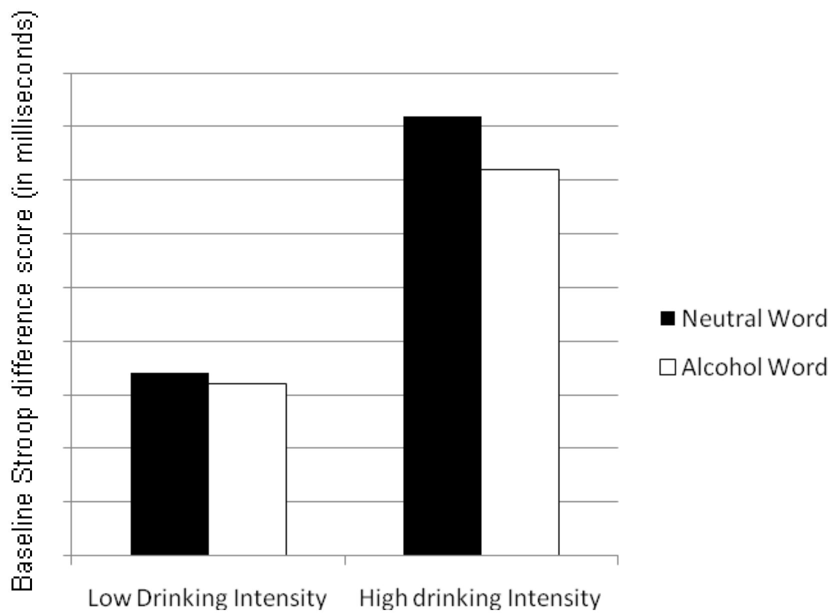


Figure 6. Baseline Stroop test response latencies × drinking intensity means.

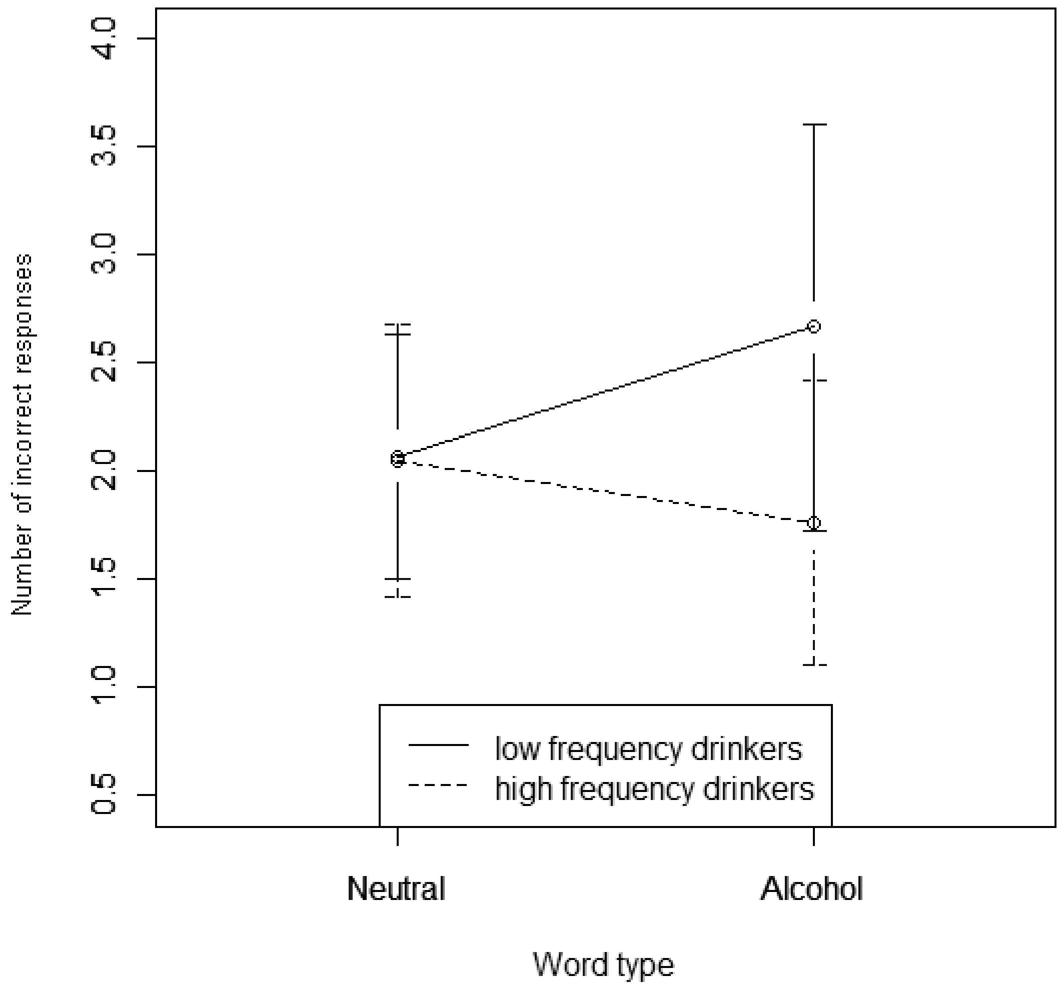


Figure 7. Incorrect color-naming for baseline Stroop test by word type and drinking frequency. Error bars represent one standard error for within-subjects terms.

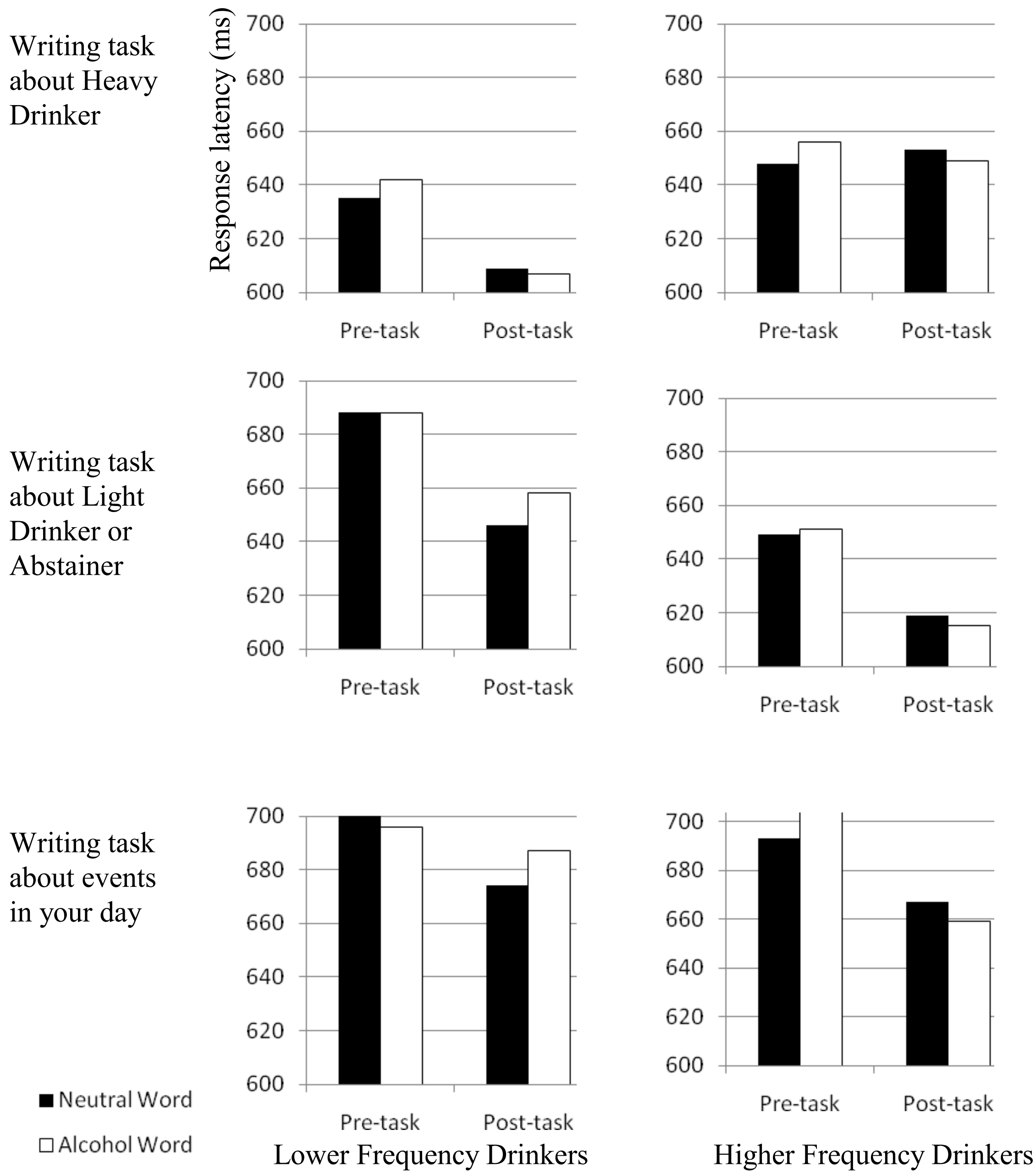


Figure 8. Mean Stroop response latencies for word type × Stroop test time × drinking frequency × condition.

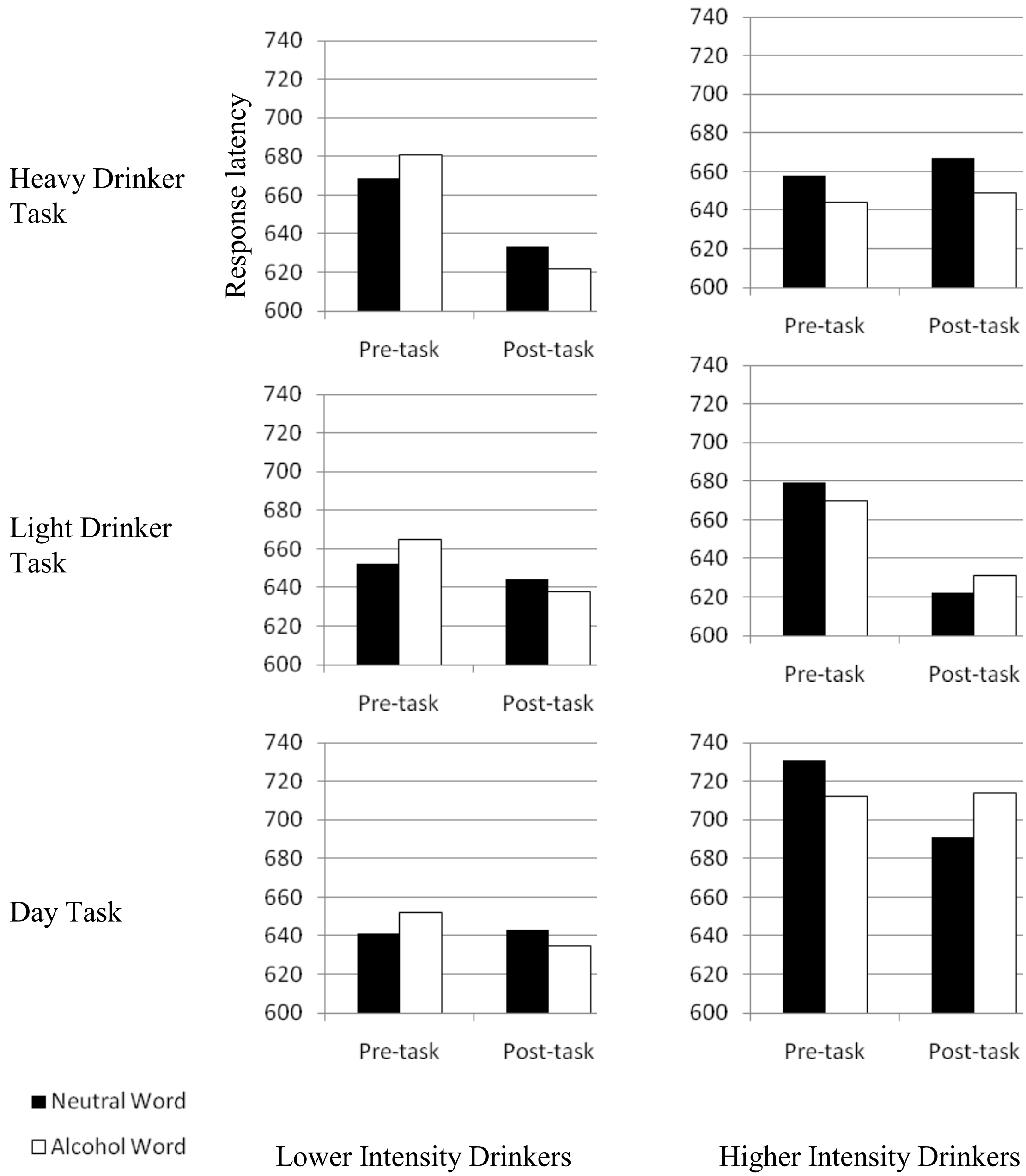
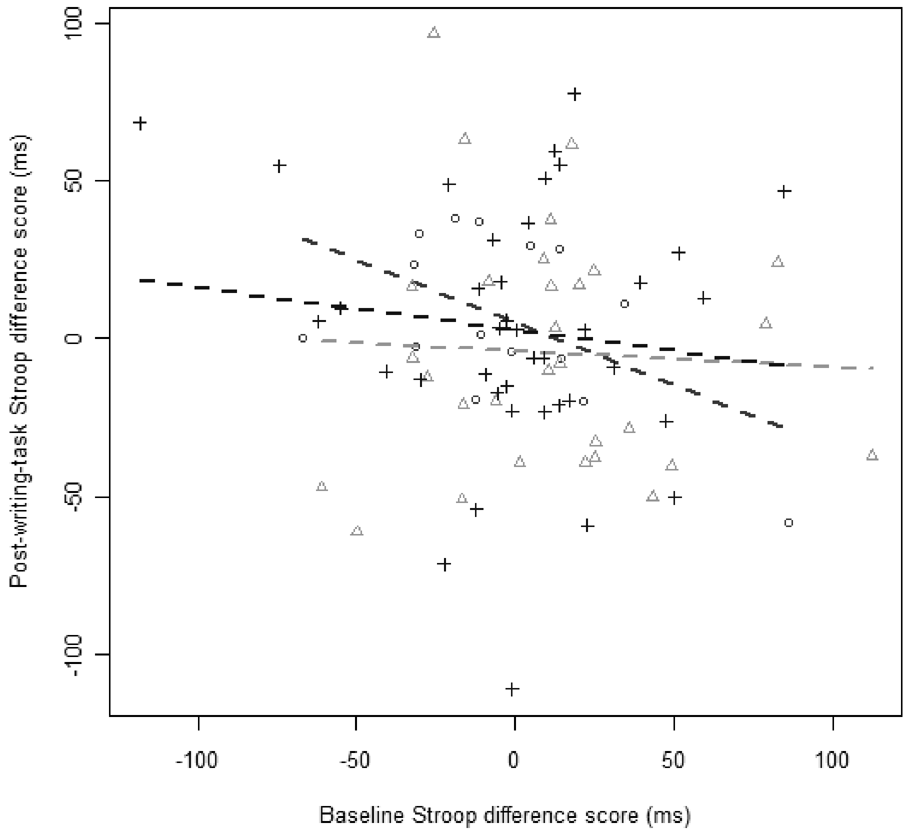


Figure 9. Mean Stroop response latencies for word type × Stroop test time × drinking intensity × condition.



Legend
+ = Light drinking or abstaining network member writing task
Δ = Heavy drinking network member writing task
o = Events in your day writing task

Figure 10. Post-writing-task Stroop alcohol interference scores predicted by condition and baseline interference scores.

Appendix

Revised IPI Questions with Codes and Scoring Algorithm

Drinking behavior index = (Q7 + Q8 + Q9)/3

General support index = (Q4 + Q5 + Q6)/3

Composite importance-drinking index = Drinking behavior index × General support index

1. Network member's name (first name & last initial)
2. Specify relationship
   - Family: mother, step-mother, father, step-father, sister, step-sister, half-sister, brother, step-brother, half-brother, daughter, step-daughter, adopted daughter, son, step-son, adopted son, grandmother, grandfather, granddaughter, grandson, aunt, uncle, cousins, other
   - Romantic relationship: girlfriend, boyfriend, fiancé, wife, husband, partner, other
   - Friend: female friend, male friend, other friend
   - Coworker: employer or supervisor, coworker, employee or subordinate, customer
   - Classmate: teacher or instructor, classmate, student
   - Extra-curricular activity associate: through a club, volunteer group, sports team or group, sorority/fraternity
   - Cohabitant (not listed as family, friend, or romantic relationship)
   - Other
3. Living in same household? (Y/N)

4. During the past 6 months, on average how frequently have you been in contact with this person?

- (5) daily
- (4) three to six times per week
- (3) once or twice a week
- (2) every other week to once a month
- (1) less than monthly
- (0) once in past six months

5. How important has this person been to you?

- (5) extremely important
- (4) very important
- (3) important
- (2) somewhat important
- (1) not very important
- (0) not at all important

6. To what extent is this person generally supportive of you?

- (5) extremely supportive
- (4) very supportive
- (3) supportive
- (2) somewhat supportive
- (1) not very supportive

- (0) not at all supportive

7. Drinking status
   - (2) heavy drinker
   - (1) moderate drinker
   - (-1) light drinker
   - (-2) abstainer
   - (-2) recovering alcoholic

8. How often does this person drink alcohol?
   - (2) daily
   - (1.5) three to six times in a week
   - (1) one or two times a week
   - (-1) about every other week
   - (-1.5) once a month
   - (-2) less than monthly
   - (-2) once in past 6 months
   - (-2) not in past six months

9. What's the *most* he/she drinks in a single day?
   - (2) ten or more drinks
   - (1.5) six to nine drinks
   - (1) three to five drinks
   - (-1) one or two drinks

- (-2) zero (doesn't drink)

10. How has (or would) this person react to your drinking?

- encouraged
- accepted
- neutral
- didn't accept
- (X) left, or made you leave

11. How has (or would) this person react to you NOT drinking?

- encouraged
- accepted
- neutral
- didn't accept
- left, or made you leave

12. Please describe the highest level of education for this person.

- Less than high school diploma/GED
- High school diploma or GED
- Some college
- Associate degree
- Bachelor's degree
- Master's degree or higher

13. What kinds of activities is this person involved with? (check all that apply)

- Arts & crafts
- Pets
- Sports
- Fitness (working out, running, etc.)
- Volunteering
- Clubs or social organizations
- Outdoors (camping, hiking, gardening, etc.)