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The Effect of Alcohol on Attention to Social Threat: A Test of the Avoidance-Coping Cognitive Model

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THE EFFECT OF ALCOHOL ON ATTENTION TO SOCIAL THREAT: A TEST OF THE AVOIDANCE-COPING COGNITIVE MODEL

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ABSTRACT

The Avoidance-Coping Cognitive model (Bacon & Ham, 2010) proposed that socially anxious individuals may be particularly vulnerable to the anxiolytic effects of alcohol through reductions in attention biases to social threat. Elements of this model and were tested in the present study, in which undergraduate volunteers (*N* = 41, 27% female) completed two dot probe tasks with photographs of angry, happy, and neutral facial expressions. Participants were randomized to either consume a moderate dose of alcohol (target BAC 0.06%) or a non-alcohol control beverage between the two dot probe tasks. Results indicated no evidence of a bias in attention to angry faces prior to beverage consumption in the overall sample, though a subset of individuals high in social anxiety showed a bias away from angry faces at 175ms and toward angry faces at 600ms. Following beverage consumption, those in the alcohol condition showed a bias toward emotional expressions overall at 600ms. Comparison with pre-beverage attention scores suggest that alcohol consumption resulted in increased attention toward happy faces, with no changes in attention to angry faces. Additionally, investigation into properties of the dot probe measure with this data revealed poor reliability and validity. Implications for the Avoidance-Coping Cognitive model and future directions are discussed.

This dissertation is approved for
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Social anxiety has been proposed as a risk factor for the development of hazardous alcohol use patterns, and particularly for alcohol dependence (Buckner et al., 2008; Buckner, Timpano, Zvolensky, Sachs-Ericsson, & Schmidt, 2008; Morris, Stewart, & Ham, 2005). Nearly half (48.2%) of individuals diagnosed with lifetime social anxiety disorder also meet criteria for alcohol use disorders based on national epidemiological data (Grant et al., 2005), which is far greater than the lifetime prevalance of either alcohol abuse (12.2%) or alcohol dependence (5.4%) in the general population (Kessler et al., 2005). The relationship between social anxiety disorder and AUDs is also supported by prospective studies. A recent study followed high school students from a mean age of 16.6 years until the age of 26 (Buckner, Schmidt, et al., 2008). Of those individuals at approximately age 16 with a social anxiety disorder diagnosis (and no diagnosis of alcohol abuse or dependence), 26% had gone on to develop a diagnosis of alcohol dependence by age 26, compared to 8.5% who developed an alcohol dependence diagnosis in the absence of an earlier social anxiety disorder diagnosis. Controlling for theoretically relevant demographic, diagnostic, and psychosocial variables (e.g., co-occurring anxiety or mood disorders, conduct disorder, gender), social anxiety disorder has been found to confer a significant and unique risk factor for the development of alcohol dependence, but not abuse (Buckner, Schmidt, et al., 2008; Buckner, Timpano, et al., 2008).

The co-occurrence of social anxiety disorder and alcohol use disorders is especially important due to the increased impairment in peer social support, greater stress in peer and family relations, increased health care utilization, and an increased likelihood of additional mental health diagnoses, compared to individuals with a unimorbid social anxiety disorder diagnosis (Buckner, Timpano, et al., 2008). Similarly, in a study of individuals seeking treatment for alcohol use disorders, those with an additional diagnosis of social anxiety disorder endorsed higher alcohol dependence, were more reliant on alcohol to improve sociability and enhance functioning, and endorsed more psychiatric problems (including a greater likelihood of depression) than those without social anxiety disorder (Thomas, Thevos, & Randall, 1999). The presence of alcohol in situations that socially anxious individuals may find threatening (e.g., parties, celebrations) may make alcohol use a more likely coping mechanism for socially anxious individuals (Morris et al., 2005).

With social anxiety disorder and alcohol use disorders being highly comorbid (Grant et al., 2005), evidence that social anxiety appears to precede the development of alcohol use disorders (Falk, Yi, & Hilton, 2008), and findings that suggest social anxiety may confer specific risk toward the development of alcohol dependence (Buckner, Schmidt, et al., 2008; Buckner, Timpano, et al., 2008), it is important to investigate the qualities of social anxiety that may lead to the exacerbated risk of developing alcohol use disorders. Attention may be one such aspect relating social anxiety and hazardous alcohol use. Attention influences the salience of environmental cues—angry faces, bottles of alcohol—and operates on motivational systems (Fowles, 1988), such as those related to escape or avoidance (Öhman, 2005) or reward activation through substance use (Robinson & Berridge, 2001). Extensive empirical findings have supported the role of attention to threat in social anxiety (Amir & Foa, 2001; Bögels & Mansell, 2004; Ledley & Heimberg, 2006; Musa & Lépine, 2000). Additionally, recent theories regarding the development and maintenance of hazardous alcohol use suggest that alcohol serves as an anxiolytic, via impairment and/or restriction in attentional processing of stress-related cues (Sayette, 1993; Steele & Josephs, 1988). When put in a larger frame of the self-medication hypothesis (Carrigan & Randall, 2003), it appears that alcohol's interruption of the cognitive processes involved in maintaining social anxiety may be a more direct mechanism for explaining alcohol's anxiolytic effects, which in turn would serve to perpetuate the use of alcohol to achieve a similar effect.

The Avoidance-Coping Cognitive Model (Bacon & Ham, 2010) is an attempt to apply general cogntive models of alcohol use (Sayette, 1993; Steele & Josephs, 1988) to the unique patterns of attention to threat evidenced by socially anxious individuals (Bögels & Mansell, 2004). A schematic of the Avoidance-Coping Cognitive Model is presented in Figure 1, and outlines the processes by which attention to threat in socially anxious individuals may influence the development of alcohol use disorders. The model proposes that avoidance of social threat in the environment both maintains social anxiety and is facilitated by alcohol use. The model involves two types of avoidance pathways: attentional avoidance of social threat cues and using alcohol to cope, which result in acute social anxiety reduction. Both share components including the introduction of social threat in the environment and vigilance toward social threat in the early, automatic stages of processing, followed by an attempt to avoid the social threat, either through attentional avoidance of the social threat cue or through the use of alcohol, which impairs attention toward social threat cues. The temporary alleviation of acute social anxiety serves as a negative reinforcer, increasing the likelihood that an individual will employ such avoidance methods in the future. For some, this might include continued alcohol use in the face of social threat. Avoidance of social threat is theorized to maintain social anxiety by preventing habituation or more elaborative processing of the actual threat posed by the cue.

Purpose of the Current Study

The current study is an initial test of the features of the Avoidance-Coping Cognitive model examining the effects of alcohol on attention to social threat in a non-selected population. There are two primary aims of the study as well as a secondary aim to examine the methodology of the dot probe:

1a. Replicate findings of the vigilance-avoidance hypothesis in a non-selected population. Previous findings (Amir & Foa, 2001; Ledley & Heimberg, 2006) have supported a bias in attention toward socially threatening cues at early stages of processing and a bias away from socially threatening cues at later stages of processing. Such findings have had greater empirical support in clinical populations, and mixed support in unselected samples. As such, we expect that bias scores will correlate with measures of trait social anxiety, such that those with higher levels of trait social anxiety will show greater degrees of attention toward social threat at earlier stages of processing and away from threat at later stages of processing.

1b. Examine changes to attentional bias following a moderate dose of alcohol. The crux of the Avoidance-Coping Cognitive model is the proposition that alcohol use reduces social anxiety through a reduction in attention toward socially threatening cues. However, despite theories of alcohol use that endorse the effects of alcohol on cognitive processes as the mechanism behind its anxiolytic effects (Sayette, 1993; Steele & Josephs, 1988), few studies have examined the effects of alcohol on changes in attention to negatively valenced stimuli (Franken, Nijs, Muris, & Van Strien, 2007; Gerlach, Schiller, Wild, & Rist, 2006; Stevens, Rist, & Gerlach, 2009). The purpose of the current study is to examine the effect of a moderate dose of alcohol on attention to socially threatening cues in an unselected sample. Again, as the Avoidance-Coping Cognitive model proposes that those higher in social anxiety will have a greater degree of bias toward social threat prior to alcohol use, it is expected that they would show the greatest change in attention following alcohol consumption.

2. Dot probe task as a measure of attention. The dot probe task was initially developed in 1986 as a method for assessing selective visual attention (MacLeod, Mathews, & Tata, 1986), and has since become a widely used task for determining attentional biases. A PsychINFO search conducted in March 2011 on the term “dot probe” yielded 256 studies. A recent meta-analysis of the anxiety literature found 30 published studies using the dot probe task to examine attention to threat cues in adult clinical and non-clinical (but identified as highly anxious through questionnaires) samples (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007). Despite its popularity, assessment of the reliability and validity of the dot probe task has rarely been conducted (Schmukle, 2005; Staugaard, 2009). Additionally, some researchers have found that bias to threat can habituate over the time course of the dot probe task and have proposed that future studies account for changes in threat salience over time (Amir, Najmi, & Morrison, 2009; Liu, Qian, Zhou, & Wang, 2006; Staugaard, 2009). Given the widespread use of the dot probe paradigm, and the surprisingly limited support for the validity and reliability of the task, a secondary aim of the current study is to examine the utility of the dot probe as the appropriate measure to use to assess the Avoidance-Coping Cognitive model. The data gathered during the course of the study were used to determine: (a) internal reliability of the dot probe task prior to alcohol consumption; (b) validity of the dot probe task by comparing bias scores with state and trait anxiety; and (c) habituation of biases in attention over the duration of the task.

1a. Replicate Findings of the Vigilance-Avoidance Hypothesis

In line with cognitive models of anxiety (Beck & Clark, 1997; Mogg & Bradley, 1998; Williams, Watts, MacLeod, & Mathews, 1988), the extant literature on attention processes in social anxiety reflects an initial, automatic attentional bias toward social threat in the environment (Garner, Mogg, & Bradley, 2006; Mogg & Bradley, 2002; Mogg, Philippot, & Bradley, 2004; Musa, Lépine, Clark, Mansell, & Ehlers, 2003). That is, among those with high social anxiety, indications of social threat (e.g., angry faces) in the environment are quickly detected and attended to, compared to individuals with lower social anxiety. The initial identification of a cue as threatening is posited to activate other cognitive and behavioral mechanisms, including autonomic arousal, a feeling of fear, and hypervigilance toward other threat cues in the environment, all intended to prepare the individual for coping with danger (Beck & Clark, 1997). In Rapee and Heimberg's (1997) cognitive model of social anxiety, the detection of social threat in the environment initiates a mental representation of themselves as seen by the audience, as well as a comparison of this self with the exacting and elevated standards that the socially anxious individual expects the audience to be using to evaluate. The potential for negative evaluation exacerbates cognitive, behavioral, and physiological symptoms of anxiety, which are then incorporated into the the mental image of the self as seen by the audience (e.g., that the audience is detecting their anxiety as manifested by sweating, shaking, blushing, or stammering).

Notably, studies have found an initial, automatic attention toward social threat in the environment in both clinical samples (Mogg et al., 2004; Musa et al., 2003) and non-clinical samples endorsing high degrees of trait social anxiety (Garner et al., 2006; Mogg & Bradley, 2002). Thus, it appears that initial attention towards social threat may exist on a continuum, and increase as trait social anxiety increases, and may not exclusively be seen only in clinical populations. Studies using non-clinical populations have found attentional biases to be associated with social anxiety above and beyond the influence of trait anxiety, depression, and negative affect, signaling that social anxiety, rather than distress more generally accounts for the biased attention toward social threat at initial stages of cognitive processing (Mogg & Bradley, 2002; Musa et al., 2003; Ononaiye, Turpin, & Reidy, 2007).

The subsequent pattern of attention towards social threat in socially anxious individuals appears to follow the vigilance-avoidance hypothesis (Mogg, Bradley, De Bono, & Painter, 1997), in which attention is captured by threat at early stages of processing, but attention is directed *away* from threat at later stages, likely in an effort towards anxiety reduction. Studies examining attention to social threat in socially anxious individuals indicate that when socially threatening cues are presented for longer durations (allowing for more elaborative processing), attention is diverted *away* from the socially threatening cue, and onto a more neutral cue, such as a non-emotional facial expression, or a neutral object (Chen, Ehlers, Clark, & Mansell, 2002; Mansell, Clark, Ehlers, & Chen, 1999). Such avoidance prevents more evaluative and elaborate processing of the threatening cue, such as considering alternative possibilities as to why an individual might have an angry expression, as well as a realistic appraisal of how to cope with the threat (Beck & Clark, 1997). Avoidant responding prevents habituation to the socially threatening cue, ensuring that it will continue to elicit anxiety in the future.

In addition to attentional avoidance, individuals may also employ other means of controlling anxiety. For instance, Rapee and Heimberg (1997) proposed safety behaviors that serve as a form of avoidance employed by individuals with social anxiety, such as avoiding eye contact during a conversation in order to reduce the likelihood of being included in the discussion and potentially embarrassing oneself. In a dot probe study examining coping responses and attentional bias, Luecken, Tartaro, and Appelhans (2004) found that amongst a non-selected sample who were initially primed for social threat, individuals who reported employing avoidant coping strategies (e.g., avoidance, wishful thinking, denial) evidenced attentional biases toward socially threatening words at earlier stages of processing, but attentional biases away from social threat at later stages. Additionally, those individuals who evidenced such a vigilance-avoidant pattern in attention to social threat also reported higher anxiety and depressive symptoms. Though the study by Luecken, Tartaro and Appelhans (2004) is not a direct evaluation of how socially anxious individuals behaviorally respond to threat, it does provide important associations linking responses on measures of attentional bias with avoidant behavioral outcomes. Thus, it appears that socially anxious individuals are characterized by initial hypervigilance toward social threat, followed by avoidance of social threat, both in terms of attentional avoidance, as well as possibly employing other behavioral responses intended to avoid social threat and in turn reduce anxiety.

1b. Examine Changes to Attentional Bias Following a Moderate Dose of Alcohol

Socially anxious individuals are characterized by a hypervigilance in attention toward threat cues at initial stages of processing, but attentional avoidance of threat cues at later stages. It is likely that a socially anxious individual encountering a social threat may employ additional avoidance strategies to cope with the threat and resulting anxiety, rather than simply avoiding visual attention. Many individuals report using alcohol in order to cope with or reduce social anxiety, regardless of the apparent inconsistency in alcohol actually eliciting anxiolytic effects (Carrigan & Randall, 2003). Further, explicit cognitions regarding drinking to cope with negative affect are associated with the development of alcohol use problems, above and beyond typical alcohol consumption levels (Carpenter & Hasin, 1999; Cooper, 1994), and drinking to cope with negative affect appears to mediate the relationship between social anxiety and hazardous alcohol use (Buckner, Schmidt, & Eggleston, 2006; Ham, Bonin, & Hope, 2007; Ham, Zamboanga, Bacon, & Garcia, 2009; Lewis et al., 2008; Stewart, Morris, Mellings, & Komar, 2006). Given that traditional theories of alcohol use posit that alcohol use is maintained through negative reinforcement via a reduction in anxiety (Conger, 1956; Khantzian, 1985; Sayette, 1993; Sher & Levenson, 1982; Steele & Josephs, 1988), it appears likely that socially anxious individuals may choose to consume alcohol as an additional way to reduce anxiety elicited by attentional vigilance toward social threat in the environment (Luecken et al., 2004).

Assuming that socially anxious individuals consume alcohol as a supplemental avoidance strategy, alongside attentional avoidance of social threat, what follows is that alcohol is an effective mechanism in reducing anxiety, via disruptions in threat-related information processing. The leading cognitive models of alcohol use suggest that alcohol either restricts attentional capacity (Steele & Josephs, 1988) or disrupts the appraisal process, and interferes with spreading activation of related memory nodes (Sayette, 1993), and that these mechanisms account for alcohol's anxiolytic effects. However, these models also purport that anxiety-related information that is processed quickly and automatically may not benefit from alcohol's effects on cognition, given that alcohol appears to negatively impact later, controlled stages of processing to a greater degree than its effects on earlier, automatic stages (Abroms, Gottlob, & Fillmore, 2006; Franken et al., 2007). It is currently unclear how alcohol may affect attention towards threat, which is generally processed quickly and automatically.

While it is generally understood that alcohol has impairing effects on cognition more generally, the precise effects of alcohol on attention are a little less clear (see Koelega, 1995, for a review). Alcohol appears to impair selective attention at controlled, effortful stages of processing that occur later in the information processing sequence, while having much less of an effect on attention at earlier automatic stages (Abroms et al., 2006). However, psychophysiological measures that are thought to reflect attentional processing show that alcohol's effects on attention may be differentially affected by the emotional content of the stimuli (Franken et al., 2007). Specifically, while alcohol may impair earlier stages of processing for pleasant, unpleasant, and neutrally valenced stimuli, only unpleasant stimuli appear to evidence impaired processing at later stages. However, it is important to note that these studies were not intended to examine individual differences in anxiety, and how such traits may influence attentional processing. Two studies have examined alcohol-induced changes in cognitive processes following social threat cues in socially anxious individuals (Gerlach et al., 2006; Stevens et al., 2009).

Gerlach and colleagues (2006) used the Stroop task to examine the social anxiety-alcohol use disorders relationship. In this study, the authors used a clinical sample of socially anxious women and a non-anxious control group to examine the effects of a moderate dose of alcohol on both attention (using the emotional Stroop task) and implicit memory for socially threatening lexical cues. The findings indicated that while both socially anxious and control participants demonstrated a higher response latency to social threat words as opposed to neutral words, alcohol attenuated the response bias in the control group only. Thus, alcohol reduced cognitive interference toward social threat cues in a control group, but the bias remained in the socially anxious group. However, socially anxious individuals did demonstrate an implicit memory bias toward socially threatening words, which was attenuated after the moderate dose of alcohol. The authors suggest that the recurrence of alcohol use among socially anxious individuals may not be due to a reduction in anxiety *per se* due to the effects of alcohol on attention, but rather impaired memory for the event.

Stevens and colleagues (2009) examined the effects of alcohol on attention using a dot probe task with photographs of faces with different emotional expressions (e.g., happy, neutral, angry, ambiguously happy, ambiguously angry) as stimuli. The authors had concluded that the results from the previous study (Gerlach et al., 2006) may have been biased by the lexical cues used in the Stroop task, which may have been so easily processed due to the unambiguous and automatic nature of reading emotionally laden words. Further, the methodology of the emotional Stroop task makes it difficult to assert that attentional processes are targeted specifically, rather than cognitive interference more generally (De Ruiter & Brosschot, 1994; Wells & Matthews, 1994). As a result, Stevens et al. (2009) chose to use photographs of individuals with different emotional expressions, as well as using the dot probe task to assess attention, which improves upon some of the methodological and interpretive difficulties presented by the Stroop task (Bögels & Mansell, 2004). Photographs of individuals expressing anger have been used frequently in studies assessing attention toward social threat (Bradley, Mogg, Falla, & Hamilton, 1998; Cooper & Langton, 2006; Mogg & Bradley, 2002), as they reflect more naturalistic and ecologically valid representations of feared social outcomes than lexical cues.

Stevens et al. (2009) included both a socially anxious group and a control group, and each group was equally divided into those who were assigned to consume a moderate dose of alcohol (targeted BAC of 0.06%) and the other half assigned to receive a control beverage. Beverages were consumed prior to the dot probe task, which used five different facial expressions (happy, neutral, angry, and the happy and angry faces each morphed with the neutral expression to create ambiguously happy and ambiguously angry faces) and two different stimulus durations—175ms and 600ms—employed as a method of assessing the stage of attentional processing (automatic vs. controlled). The results indicated that socially anxious individuals who did not consume alcohol evidenced the expected attentional bias toward social threat (e.g., angry face) at early automatic stages of processing. Socially anxious individuals who did consume the moderate dose of alcohol did not evidence attentional biases toward social threat at 175ms, suggesting that alcohol attenuated attentional biases toward social threat. No attentional bias effects were demonstrated at later stages of processing in either the alcohol or control condition, suggesting that attention may not be biased either toward or away from social threat at later stages of processing.

The summation of literature involving the effects of alcohol on attentional processes suggests that both automatic and controlled attentional processes are affected by alcohol, though controlled processes may be more susceptible, particularly in response to the processing of negatively valenced information (Franken et al., 2007). However, among socially anxious individuals, it appears that only automatic attentional biases to threat are reduced due to effects of alcohol, while alcohol does not appear to affect later, controlled attention (Stevens et al., 2009). One explanation for these seemingly disparate findings may be that due to socially anxious individuals' biased attention toward social threat at the earlier stages of attentional processing, alcohol may have a more dramatic effect in terms of resulting anxiety reduction. Alcohol did not appear to impact attentional biases when measured at 600ms (during controlled processing) in Stevens et al. (2009); in fact, socially anxious individuals showed neither a bias toward or away from social threat at 600ms, regardless of alcohol consumption. One possibility for this finding resides in the methodology of the dot probe task, which measures only where attention was focused at the time of stimulus offset, and cannot ascertain where attention was allocated throughout the duration of the stimulus presentation. If alcohol is expected to have the greatest impact at these later, more controlled, stages of information processing (Abroms et al., 2006), the variability in attention caused by alcohol may negate any attentional biases towards or away from threat when assessed using the dot probe task.

Based on both theory and the limited empirical base, the Avoidance-Coping Cognitive model proposes that alcohol has a deleterious effect on both automatic and controlled attention to threat amongst socially anxious individuals. However, social anxiety appears to be elicited predominantly by an attentional bias toward social threat at earlier, automatic stages of processing, and reduced via avoidance of social threat at later stages. Thus, alcohol may have a greater effect on reducing anxiety due to its effects on reducing attentional biases that occur at the earlier, more automatic stages. Subsequent impairments of attentional biases during later stages of processing following alcohol consumption may not have as much of an effect on social anxiety, as the need for attentional avoidance might be unnecessary if attention is not biased toward threat intially. Alcohol use may be especially reinforcing for individuals with heightened social anxiety, due to the increased levels of automatic attention to threat they encounter, and the subsequent disproportionate reduction in attention at these automatic stages due to alcohol, when compared with nonanxious individuals. Alcohol use may then serve to facilitate cognitive avoidance strategies of reducing anxiety that were otherwise achieved via attentional avoidance of social threat (Chen et al., 2002).

The Avoidance-Coping Cognitive Model aligns with general theories regarding alcohol use as negatively reinforcing via its reduction in anxiety (Conger, 1956; Sher & Levenson, 1982). As individuals with heightened social anxiety are expected to experience a more drastic reduction in anxiety (due to aforementioned reduction in automatic attention towards social threat), they may be more likely to use alcohol to achieve the desired anxiolytic effects. This may be further exacerbated due to the fact that alcohol may be frequently consumed in contexts that can be socially stressful, such as parties, dates, and business gatherings. The abundance of cues that could be seen as potentially threatening, coupled with the socially sanctioned act of alcohol consumption during these events suggests that alcohol consumption to attentuate anxiety due to social threat may be increasingly likely.

2. Dot Probe Task as a Measure of Attention

As noted earlier, the dot probe task has been widely used as a measure of biased attention not only within the anxiety literature, but also to assess attention in alcohol use disorders (Loeber et al., 2009), eating disorders (Brooks, Prince, Stahl, Campbell, & Treasure, 2011), and depression (Peckham, McHugh, & Otto, 2010). Despite the widespread popularity of the dot probe as a measure of biased attention, evaluation of the psychometric properties of the dot probe task have been limited (Cisler, Bacon, & Williams, 2009).

Reliability. Assessment of the dot probe task itself as a reliable measure has been limited to only two published studies: Schmukle (2005) and Staugaard (2009). Schmukle (2005) proposed that inconsistent findings of attentional bias within non-clinical samples may be a feature of poor reliability of the dot probe task. Using a non-selected sample of undergraduate students and both words and pictures as stimuli, the author found poor internal consistency (assessed by split-half and Cronbach alpha) and poor test-retest reliability over one week with the dot probe task. Staugaard (2009) similarly found poor internal consistency and test-retest reliability in a non-selected sample using facial photographs. Though extant findings using clinical populations appear to be more consistent in finding attentional biases, no studies to date have published reliability psychometrics for the dot probe task among clinical populations.

Validity. The dot probe is one of several different tasks used to assess attentional biases, with biased attention toward threat-related cues serving as a theoretical foundation in cognitive models of anxiety (McNally & Reese, 2009). The validity of the dot probe may encompass two general questions: (1) Does the dot probe measure attention and capture biases in attention? and (2) Is biased attention (as assessed by the dot probe) associated with anxiety?

The dot probe uses reaction times to identify the location of probes (either replacing a critical cue or opposite the critical cue) to infer where a participant was focusing their attention when the cues were removed (MacLeod et al., 1986). The dot probe is considered a test of selective visual attention, whereas other attentional tasks are thought to measure different components of attention. For example, the emotional Stroop task is another common measure in both the anxiety and alcohol literatures (Williams et al., 1988). While long identified as a measure of attentional bias, alternative explanations for variations in reaction times have been proposed, such that the Stroop task may be best considered as a measure of interference in processing or response inhibition (De Ruiter & Brosschot, 1994; Wells & Matthews, 1994). Indeed, the dot probe and Stroop tasks are have been largely uncorrelated among measures of anxiety (Dalgleish et al., 2003; Mogg et al., 2000), depression (Gotlib et al., 2004), substance use (Spiegelhalder et al., 2011), and sleep (Spiegelhalder et al., 2010), indicating they are likely measuring different aspects of attentional processes. The dot probe has recently been compared to eye-tracking machines, which are able to follow eye movements in relation to items on a screen for a duration of time, as opposed to the “snapshot” view of attention at the time of the offset of the cue in the dot probe. These studies suggest agreement between the dot probe task and fixation times during eye tracking, though they conclude that eye tracking is a more sensitive measure of visual attention (Isaacowitz, Wadlinger, Goren, & Wilson, 2006; Miller & Fillmore, 2010). Notably for the present study, a significant relationship between attention bias toward alcohol cues as measured by the dot probe and fixation times with eye tracking was maintained (and even strengthened) following a low dose (average BAL = 0.04 g/100ml) of alcohol (Schoenmakers, Wiers, & Field, 2008). Thus, the dot probe as an indirect measure of attention (e.g., inferred from reaction time differences) is supported by the more direct method of tracking eye movements.

The second overarching question regarding the validity of the dot probe task concerns whether attentional biases (as measured by the dot probe) demonstrate predicted relationships with anxiety-related variables. In terms of predictive validity, evidence of decreased anxiety following attentional training tasks (wherein attentional biases are "trained" away from social threat using the dot probe task; Amir, Weber, Beard, Bomyea, & Taylor, 2008; Schmidt, Richey, Buckner, & Timpano, 2009), as well as evidence that attentional biases to threat are reduced following cognitive-behavioral psychotherapy (Mogg, Bradley, Millar, & White, 1995), suggest more than a spurious association between behavioral and emotional manifestations of anxiety and attentional biases. Evidence regarding concurrent validity—that is, the degree to which attentional biases to threat cues are related to other measures of anxiety collected at the same time—is equivocal. Mogg, Bradley, De Bono, and Painter (1997) found that non-selected individuals scoring high in state anxiety evidenced attentional biases toward threat words, while those low in state anxiety did not display biased attention. However, later studies with non-selected populations correlating self-reported state anxiety with attentional bias scores have yielded non-significant relationships (Schmukle, 2005; Staugaard, 2009). A recent study assessed the relationship of heart rate and attentional biases toward spiders measured by the dot probe, and found a significant positive correlation as well as attentional bias scores served as a significant predictor of heart rate variability among a non-selected sample (Van Bockstaele et al., 2010). Finally, a meta-analysis of studies examining attention to threat reported that within-group attentional biases occurred for both clinically anxious and non-clinical highly anxious individuals, while non-anxious (non-clinical or non-clinical low anxiety) control groups did not (Bar-Haim et al., 2007). Thus, within a non-selected population, it may be expected to find correlations between measures of anxiety and attentional bias.

Habituation. The dot probe task—as many information processing tasks—relies on repeated trials to arrive at a mean response time. Knowing that anxious responding decreases with exposure to anxiety relevant cues through habituation (Foa & Kozak, 1986), it may be important to investigate changes in attention occuring within the span of a dot probe task. There is evidence of habituation over the course of the emotional Stroop task, with two studies finding evidence of increased interference in processing in the first "block" or section of the Stroop task compared to later blocks (McKenna & Sharma, 1995; McNally, Riemann, & Kim, 1990). More recently there have been efforts to chart changes in attentional biases over the course of the dot probe task, all with non-clinical samples. Liu, Qian, Zhou, and Wong (2006) examined changes in attentional bias to threatening pictures over four different "blocks" of repeated trials (each block with 72 trials) for individuals high and low in trait anxiety. Among the high anxious participants, attentional bias toward threatening images was maintained throughout the first three blocks, with no significant bias at the fourth block. There was no difference in attention between the blocks for the low anxious participants, and none of the blocks indicated a significant bias in attention. Amir, Najmi, and Morrison (2009) found similar results with non-clinical participants scoring high and low in a measure of obsessive-compulsive (OC) symptoms. In this study, high-OC individuals evidenced a significant bias in attention toward ideographically rated threat words during the first block of word pairings (approximately 100 trials in each block), but no signifiant biases in the remaining two blocks. Like in the previous study, low-OC participants evidenced no significant biases toward or away from threat words, and did not show any significant differences in responding. The authors note that evaluating all the trials across the study, as is typical, would have yielded no evidence for a significant group x attention bias interaction. Contrary to these findings Staugaard (2009) found no evidence of changes in attentional biases to threat faces between the first and second half of the study (8 blocks of 36 trials in each block), nor between the first task and a second task completed approximately 8 days later. The participants in this study were non-selected, not differentiated on any measure of anxiety (though there were no significant correlations between bias scores and state anxiety), and were found to have significant biases toward both angry and happy faces. Staugaard (2009) differed in methodology for assessing changes in attention by using a less sensitive method of examining changes (more repetitions of stimuli within each half of the task). Though Staugaard (2009) did find decreases in biases toward angry faces between the first and second half of the study, it did not reach significance. With the exception of Staugaard (2009), there appears to be evidence that biases toward threat decrease over the course of the dot probe task.

Present Study

The purpose of the present study was to test the Avoidance-Coping Cognitive model in a sample of non-clinical undergraduate students who endorse social drinking by *(*1a) replicating findings of biases toward social threat at earlier stages of processing and away from threat at later stages of processing (Mogg et al., 1997). Such findings have been consistently demonstrated in socially anxious individuals (Bögels & Mansell, 2004), but findings in non-clinical populations have been less consistent (Cooper & Langton, 2006; Garner et al., 2006; Mogg & Bradley, 2002). To that extent, the relationship of attentional biases to measures of trait social anxiety was also examined. (1b) Investigating changes in attention to social threat after consuming a moderate dose of alcohol (target BAC = 0.06%) in a simulated bar-laboratory. (2) Assess the reliability and validity of the dot probe task as a measure of attention to test the Avoidance-Coping Cognitive model. Specifically, examine internal consistency of the task and the degree to which changes in attentional bias correspond with state social anxiety and physiological measures of anxiety (e.g., heart rate).

Hypotheses

Attention to social threat. Based on the extant literature regarding attentional biases to social anxiety, attentional biases to social threat at baseline were expected for all participants. As discussed in more detail in the Method section, attentional biases toward social threat in the dot probe task were evidenced by faster response times to probes replacing social threat cues, and slower response times to probes replacing neutral cues. The converse is true for biases in attention *away* from social threat. Specifically, positive bias scores (attention toward threat) were expected at earlier stimulus durations, and negative biases scores (attention away from threat) were expected at later stimulus durations, which reflect a vigilance-avoidance pattern typically seen in attention to social threat (Bögels & Mansell, 2004). Further, it was predicted that these biases will be exacerbated as trait social anxiety levels increase, such that individuals with heightened levels of trait social anxiety are expected to experience greater attentional biases toward social threat at earlier stimulus durations, and greater attentional biases away from social threat at later stimulus durations.

Changes to attentional bias following alcohol consumption. Based on findings by Stevens, Rist, and Gerlach (2009), it was expected that the consumption of alcohol would alter attentional processes, specifically as it pertains to attention toward social threat. Attention towards both types of cues (happy faces and angry faces) was expected to remain relatively constant in individuals who consume no alcohol between the first and second dot probe tasks. However, attentional biases to the social threat cues were predicted to change following alcohol consumption, reflected as a decrease in both positive bias scores (indicating biased attention toward social threat) and a decrease in negative bias scores (indicating biased attention away from social threat). As before, it was predicted that changes in attentional bias following alcohol consumption would be exacerbated as trait social anxiety levels increase.

Dot probe as a measure of attention. The Avoidance-Coping Cognitive model relies on empirical evidence primarily from studies employing the dot probe task to support hypotheses regarding the role of alcohol in reducing social anxiety, due to its widespread use in both the anxiety (Bar-Haim et al., 2007; Bögels & Mansell, 2004; Mogg & Bradley, 1998) and alcohol use literatures (Loeber et al., 2009). However, the psychometric properties of the dot probe task have rarely been examined (Schmukle, 2005; Staugaard, 2009). Toward that end, it was predicted that: (*a*) the internal reliability of the dot probe task prior to alcohol consumption, as measured by split-half and Cronbach alpha, would indicate adequate internal consistency, (*b*) the validity of the dot probe task would be demonstrated by evidence of significant correlations between bias scores and measures of state and trait anxiety; and (c) habituation of biases in attention would be demonstrated via decreases in biased attention over the duration of the task.

Method

Participants

Participants were recruited from Fall 2009 to Spring 2010 from undergraduate psychology courses at the University of Arkansas to take part in the current study in exchange for course-required research credit or extra credit. Interested individuals (n = 81) contacted the Laboratory for Anxiety and Substance Abuse Research (LASAR) and underwent an initial brief telephone screening to determine initial eligibility. Of the initial interested individuals, 55 met preliminary criteria and were scheduled to undergo a medical screening interview immediately prior to the onset of the study. The lengthier in-person medical screening was conducted to ensure participants met eligibility criteria for the study (i.e., 21 years of age, no medical conditions that might be exacerbated by alcohol, no suicidality or psychotic symptoms, not pregnant or breastfeeding, not taking any medications other than contraceptives, no problematic reactions to drink ingredients or to consuming two alcoholic beverages in one sitting, have experience drinking at the 0.06/100ml alcohol level administered in the study, and are not currently using alcohol at problematic levels requiring intensive treatment (defined as a score of > 15 on the Alcohol Use Disorder Identification Test [AUDIT], Babor, Higgins-Biddle, Saunders, & Monteiro, 2001). Seven potential participants were excluded from further participation by not meeting these eligibility criteria. Additionally, participants were instructed at the end of the telephone screening not to use drugs or medications (other than birth control) or to drink alcohol for 24 hours prior to their appointment, and not to eat for 4 hours prior to their appointment. In cases where participants failed to comply with these guidelines, they were rescheduled as space allowed—however, four participants were not able to be rescheduled and were excluded from further participation after failing to meet these guidelines. Though 44 participants completed all stages of the study, the data from one participant was removed after preliminary analysis revealed excessive errors in the dot probe task (discussed in Results section) and the data from two participants in the alcohol condition were removed after failing to reach a BAC of at least 0.05%mg/g. In total, analyses were conducted on 41 participants: 22 in the alcohol condition and 19 in the control condition. Demographic information is presented in Table 1.

Measures

The assessment strategy involved three levels: screening, baseline assessment, and dependent measures.

Screening interview. A medical screening interview was conducted with participants at the beginning of the study in order to assess for eligibility criteria, including medical history, medications, suicidality, psychotic symptoms, and hazardous drinking. Trained doctoral students conducted all screening interviews under the supervision of a licensed clinical psychologist. The medical interview included sections of the *Anxiety Disorders Interview Schedule for DSM-IV* (ADIS-IV; DiNardo, Brown, & Barlow, 1994) to assess for suicidality and psychotic symptoms, and the AUDIT to assess for hazardous drinking (see below).

The AUDIT is a ten-item measure that was administered verbally during the medical interview to assess components of hazardous drinking. The psychometric qualities of the AUDIT have been well-established overall, with internal consistencies ranging from α = .59 -. 97 (see Reinert & Allen, 2007 for a review), as well as in college students (Kokotailo et al., 2004). In the current study, α = .53, indicating a lower reliability in the current sample of undergraduates.

Baseline assessment and dependent measures.

Demographics. A basic demographic questionnaire assessed gender, age, race/ethnicity, year in college, marital status, employment, living arrangements, and age of first alcohol consumption (see Table 1).

Trait social anxiety. Trait social anxiety was measured by the self-report version of the Liebowitz Social Anxiety Scale (LSAS-SR; (Cox, Ross, Swinson, & Direnfeld, 1998; Liebowitz, 1987). The LSAS-SR assesses the severity of both fear and avoidance of 24 different social situations, including both social interaction and social performance scenarios. The LSAS-SR shows comparable results to the original, clinician-administered format (Fresco et al., 2001; Rytwinski et al., 2009) and has strong internal consistency in both socially anxious clinical patients (α =.95) and non-anxious controls (α =.94) (Fresco et al., 2001). The LSAS-SR consists of six subscales: Fear of Social Interaction, Fear of Performance, Avoidance of Social Interaction, Avoidance of Performance, Total Fear and Total Avoidance (α's = . 71- . 91 in non-clinical populations, and α's = .82 - .91 in clinical populations). The LSAS-SR was used in the present study to assess how differences in attentional biases differ by degree of trait social anxiety. Alphas for the present sample were good to excellent, at α = .89 (Total Fear) and α = .89 (Total Avoidance).

Positive and negative affect. The Positive and Negative Affect Scales (PANAS; Watson, Clark, & Tellegen, 1988) is a 20-item self-report questionnaire assessing degree of current positive and negative feelings and emotions (10 items each) on a 5-point scale.

The negative affect scale was included for use as a potential covariate to ensure that responses were related to social anxiety specifically, rather than negative affect more generally. The PANAS negative affectivity scale has good internal consistency (α = .84 - .87) as well as discriminant and convergent validity (Watson et al., 1988). Analysis of the internal consistency of the present sample yielded α = .90 for the positive affect scale, and α = .70 for the negative affect scale.

State social anxiety. The Subjective Units of Distress Scale (SUDS; Wolpe, 1973) and the State Social Anxiety Questionnaire (Kashdan & Steger, 2006) were used to assess state social anxiety. The SUDS is a single-item rating of current anxiety on a scale from 0 (*no anxiety*) to 100 (*maximum anxiety*), with intermittent anchors (e.g., a score of 50 represents *moderate anxiety*). Participants were instructed at the beginning of the study about the types of feelings associated with each of the boundaries and anchors. The SUDS is commonly used in treatment and research for the assessment of anxiety (Davidson et al., 2004; Kocovski & Rector, 2008).

In order to assess social anxiety specifically, an adaptation of a state social anxiety measure constructed by Kashdan and Steger (2006) was administered prior to each dot probe task (before and after beverage administration). The State Social Anxiety Questionnaire was developed to assess social anxiety over the course of an entire day, and consists of items from the Fear of Negative Evaluation scale (Rodebaugh et al., 2004) and the International Consensus group on Depression and Anxiety (Ballenger et al., 1998). Kashdan and Steger (2006) found strong convergent validity (correlation of r = .56 between state social anxiety and trait social anxiety measures), and specificity between measures of state and trait social anxiety in their sample of 97 college students. The 7-item, 5-point Likert scale was adapted for this study to better reflect feelings occurring in the last 15 minutes, rather than the past day. Internal reliability in the current sample ranged from acceptable during the first administration ($\alpha = .68$) to excellent after the second administration (following beverage consumption; $\alpha = .94$).

***Physiological anxiety*.** Average pulse rate during different segments of the protocol was assessed using a Suunto t3 heart rate monitor, a sports recorder consisting of a watch and a chest band containing electrodes that measure electric signals from the heart. The use of a sports recording device to assess pulse rate was found to be reliable and accurate, and comparable to more sophisticated physiological equipment ($r = .98$; Dahlstrom & Nahlinder, 2006).

Dot probe task. The dot probe task (MacLeod et al., 1986; Mogg & Bradley, 2002) is a computer-based task used to assess selective visual attention. As shown in Figure 2, the task began with an orientation field in the center of the screen, displayed for 1000ms, to orient individuals to a neutral location. Immediately following the orientation screen, a face pairing with one face on the top of the screen and one on the bottom was presented. The faces were displayed for either 175ms or 600ms, at which point the facial stimuli were removed from the screen and a “probe” (*) appears in the location of one of the two cues. The participant was instructed to indicate, by key press, the location of the probe (top or bottom) as quickly as possible. The probe remained on the screen until the participant responded. Attentional bias is inferred by response time latencies: faster response times to the location of a probe indicate that attention was focused on the face present in that location immediately prior to the appearance of the probe. Conversely, slower reaction times to the location of the probe indicate that attention was focused away from the face that the probe had replaced.

The main dot probe task consisted of five practice trials, followed by 384 experimental trials. Trials were determined by a 4 (actor) x 3 (face pairs: angry/neutral; happy/neutral; neutral/neutral) x 2 (probe locations: top, bottom) x 2 (emotional face locations: top, bottom) x 2 (stimulus duration: 175ms, 600ms) design, yielding 96 trials. The 96 trials were presented in four blocks, yielding 384 experimental trials, with the same pictures randomized within each block. The block design allowed for an assessment of habituation of attentional biases over the course of the dot probe task (Liu et al., 2006). Of the 96 total trials, 64 were “critical trials”—that is, an emotional face paired with a neutral face. With this design, faces were displayed with equal frequency on the top and bottom of the screen, and probes replaced emotional and neutral expressions with equal frequency.

Stimuli. Photographs of actors displaying different facial expressions of emotion were selected from the Ekman and Friesen (1976) photo set, “Pictures of Facial Affect.” Four actors (2 female, 2 male) were chosen, with photos of each of them displaying three emotions: happy, angry, and neutral. Photographs of the same person were paired, with one photograph containing an emotional expression (e.g., angry or happy) and the other a neutral expression. Additionally, in order to test for baseline attention, the same actor displaying a neutral expression was paired together to comprise a neutral/neutral pairing.

Procedure

Prescreening. Undergraduate students in introductory to psychology courses interested in participating in the study were instructed to call into the laboratory in order to complete a telephone screening. Participants were informed during the telephone screening that they may consume an alcohol dosage equivalent to a breath alcohol level (BAL) of up to 0.06g/100ml during the course of the experiment, and that the study would take approximately 3 to 4.5 hours to complete, depending on experimental condition. Participants were asked information about health history, medications, and alcohol use history in order to ensure that they may safely consume alcohol at the level administered in the study (National Institute on Alcohol Abuse and Alcoholism, 2005). Eligible participants who were interested in continuing in the study were scheduled for a laboratory session, and asked not to consume alcohol within 24 hours, medications (other than contraceptives) within 24 hours, or food or drink within 4 hours of their scheduled laboratory session, in order to ensure predictable absorption of alcohol. Participants were instructed that should they consume alcohol, they would be asked to turn over their keys and arrange for a ride home when they were at a safe BAL (≤ 0.04g/100ml). Participants were scheduled to arrive at the laboratory between 4:00-5:00 pm, in order to increase the ecological validity by having individuals consume alcohol during the early evening hours.

Informed consent and medical screening. Upon arrival to the laboratory on the day of the scheduled session, participants were administered a baseline BAL test to ensure sobriety using an Intoximeter® Alco-Sensor FST, a Department of

Transportation-approved measurement device for BAL. Participants were asked to verbally report compliance with pre-session instructions. Participants who did not comply with pre-session instructions were not permitted to continue with the experiment on that day, and were asked to reschedule for a different night, based on availability. Those who did comply with the instructions were asked to provide verbal and written informed consent.

Graduate-level research assistants completed an in-depth medical screening, assessing medication use, medical history, and alcohol use in order to ensure that participants had no medical conditions that might be exacerbated by alcohol, had no suicidality or psychotic symptoms, were not pregnant or breastfeeding, were not taking any medications (other than contraceptives). Participants were also asked if they had recent history of drinking at the dose provided in the study, and asked for indications of hazardous alcohol use. Research assistants oriented participants who successfully met study eligibility requirements following the medical screening to the SUDS, and obtained the participant’s weight using a medical-grade scale in the laboratory in order to complete calculations for beverage administration (see below).

Pre-test. Following successful completion of the medical screening, participants moved to the computer lab to complete computerized questionnaires, including demographics, measures of state and trait social anxiety, problematic alcohol use behaviors, and positive and negative affect. Heart rate measurements were also assessed during this time. Participants then completed the first administration of the dot probe task. A research assistant was available in the room to answer any questions and to ensure compliance with the task.

Beverage consumption. Graduate research assistants prepared the beverages for the alcohol administration portion of the protocol while participants were completed the computer-based tasks in another room. Participants were randomly assigned to one of two beverage conditions by coin-toss: alcohol (target BAL of 0.06g/100ml) and a no-alcohol control. All participants scheduled on the same evening were in the same condition. Participants in the alcohol condition consumed a mixture of Cherry 7-up, lime juice, and 40% alcohol by volume vodka to achieve a target peak BAL of 0.055 to 0.065g/100ml at 20 – 30 minutes after consumption, assuming an average 0.15g/100ml per hour metabolism rate. The amount of alcohol was calculated with a modified version of the formula from Fisher et al. (1987) using the gender and weight of the participant (MacDonald, Baker, Stewart, & Skinner, 2000), such that men received 2.12ml of alcohol per kilogram of body weight, and women received 10% less (1.91ml of alcohol per kilogram of body weight; Friel, Logan, O'Malley, & Baer, 1999). Participants in the control condition consumed only the Cherry 7-up and lime juice mixture with same amount of liquid as someone of their gender and weight in the alcohol condition.

Participants were informed of their beverage condition following completion of the questionnaires and dot probe task, and taken to a simulated “bar” designed to increase ecological validity. Participants consumed their calculated beverage amount divided into three glasses, and were asked to finish within a 20 minute timeframe. Blood alcohol level was measured 20 minutes and 30 minutes after participants had finished their last drink.

If participants in the alcohol condition did not reach the target peak (at least 0.05g/100mg BAL), they were assessed at 10 minute intervals until target had been reached before moving on to the next stage in the study. For those participants who appeared to peak at a BAL of less than 0.05, they were asked to complete the remainder of the study, and their data was excluded from further analyses (n = 2). Heart rate and state anxiety were assessed at the beginning of the drinking period, at the beginning of the absorption period and at the end of the absorption period.

Post-test. Participants completed measures of state social anxiety after reaching the target BAL (or after beverage completion for the control condition), and then completed the dot probe task a second time. The second dot probe task consisted of different actors in order to reduce potential practice effects or habituation, but maintained the same parameters of gender and facial expression as in the first dot probe. The actors in the first and second dot probe task were counterbalanced across participants. Participants were monitored during completion of this task to ensure compliance with the task and to provide assistance if participants experienced adverse reactions to alcohol.

Debriefing and detoxification. After completion of the second dot probe task, participants completed a manipulation check questionnaire regarding their beliefs and perceptions about the beverage they were assigned and (if applicable) their perceived level of intoxication. Following completion of this measure, participants were fully debriefed. Those in the control condition were permitted to leave, while those in the alcohol condition had their BAL measured every 10 – 15 minutes, and were permitted to leave the lab after two consecutive readings of ≤ BAL .04g/100ml and after securing a ride home.

Sample Size and Power Analysis

A limited number of studies have investigated the effects of alcohol on attention to threat in a socially anxious population. In the closest approximation to the methodology used in the proposed study, Stevens and colleagues (2009) found a moderate effect ($\eta^2_p = 0.09$; Cohen, 1988) in a beverage (alcohol vs. control) x group (clinical social anxiety disorder vs. nonanxious control) x probe position interaction examining attention to angry faces using the dot probe task. Based on this effect size, a minimum of 30 subjects ($n = 15$ for two between-subjects beverage conditions) was necessary in order to obtain a power of .80 in a repeated measures ANOVA with one between-subjects level, (G*Power 3; Faul, Erdfelder, Lang, & Buchner, 2007). However, aspects of the Stevens et al. (2009) study used to estimate effect size for the current power analysis may be expected to yield larger between- and within- group differences than the methodology used in the proposed study. Notably, Stevens et al., (2009) examined participants meeting diagnostic requirements for social anxiety disorder, and only analyzed angry facial expressions to arrive at the effect size used to estimate power for this study. Aspects of the proposed design (e.g., a non-selected sample, analyzing angry and happy facial expressions, rather than just angry faces) were expected to yield smaller effects. Thus, the targeted sample size was increased to 40 participants, in order to ensure that effects would be detected if present.

Results

Data Preparation

Incorrect responses to the dot probe and response times less than 200ms were removed from analyses. Each data block was then analyzed separately for response times greater than 3 standard deviations from each individual mean, which were removed from analyses as within-subject outliers (Amir et al., 2009). One participant in the control condition was removed from all subsequent analyses due to excessive errors and response time outliers (greater than 50% of data removed from each block). Additionally, one participant in the control condition (Time 1) and one participant in the alcohol condition (Time 2) had excessive within-subject outliers in block 4 only, and their data was removed from only that block for analyses. A total of 2.53% of the data from Time 1 and 3.06% of the data from Time 2 were removed from analyses due to incorrect responses and within-subject outlying reaction times. In total, analyses were conducted on 41 participants (22 in the alcohol condition, 19 in the control condition) for the first three dot probe blocks and 40 participants in the fourth block for both Time 1 administration (22 in the alcohol condition, 18 in the control condition) and the Time 2 administration (21 in the alcohol condition, 19 in the control condition).

Preliminary Analyses

Prior to collapsing response times for analyses, preliminary analyses were conducted to ensure no systematic bias in elements of the study design not under investigation. There were no significant differences in response times by actor, gender of actor, or whether the face of interest (angry or happy face) was presented on the top or bottom. Response times were significantly faster when the probe was presented on the top (*M* = 463ms, *SD* = 65) than when the probe was presented on the bottom (*M* = 475ms, *SD* = 60; $t(40) = 3.68$, $p = .001$), which is in line with previous findings (Chen et al., 2002) and not expected to bias subsequent analyses, as congruent and incongruent trials were equally presented with the probe on top and the probe on bottom. Response times to individual trials were subsequently collapsed by time of presentation (Time 1: prior to beverage administration; Time 2: after beverage administration), block of data (overall across all blocks, and for blocks 1-4 to examine habituation), stimulus duration (175 ms; 600ms), congruency (congruent: probe replaced angry/happy face; incongruent: probe replaced neutral face when presented with angry/happy face; neutral: two neutral faces presented together), and facial expression (angry, happy, neutral).

A review of the collapsed reaction time data indicated positive skew, with the majority of the data yielding skew scores greater than 1. Boxplot analyses also indicated the presence of regular between-subject outlying reaction times. In order to reduce the data skew, outliers in each time x block x stimulus duration x congruency x facial expression summary were Winsorized at the upper Tukey's hinge to normalize outliers (Fox & Knight, 2005). Mean reaction times (after Winsorization) are reported in Table 2.

For planned follow-up analyses, bias scores were computed for both happy and sad faces at each of the two stimulus presentation times (175ms, 600ms). Bias scores (incongruent trials – congruent trials) indicate both the direction (positive scores indicate biased attention toward the emotional face; negative scores indicate biased attention away from the emotional face and on to the neutral face), and degree of the bias (by comparing with a score of 0, indicating no bias). Bias scores were computed for each of the four blocks, so that habituation of attention over time could be assessed (Amir et al., 2009; Liu et al., 2006). No differences between the beverage groups in overall bias scores were observed during Time 1, prior to beverage consumption (*F*s = .002 – 1.53; *p*s = .22 - .96).

Bivariate correlations were conducted to explore potential covariates between bias scores and questionnaire data on state and trait social anxiety, negative affect, drinking to cope, and alcohol dependence. Only drinking to cope demonstrated a significant relationship with any of the bias scores (Time 1 Angry faces at 175ms; $r = -.36$, $p = .02$), such that individuals who reported drinking in order to cope with negative affect were more likely to show attention *away* from angry faces at 175ms prior to beverage consumption. Drinking to cope was initially included as a covariate in all Time 1 analyses, though it failed to reach significance in any of the analyses and was dropped.

1a. Attentional Bias to Threat Prior to Beverage Consumption

A 2 (expression: happy, angry) x 2 (congruency: congruent, incongruent) ANOVA was conducted with reaction times as dependent variables, and expression and congruency as within subject variables, for each of the stimulus duration times (175ms, 600ms). Data were collapsed across beverage condition, as participants had not consumed beverages or been told their respective beverage conditions at the time of the first dot probe task. Preliminary analysis comparing the alcohol and control groups on overall responses to each of expression x congruency reaction times yielded no differences and supported collapsing across beverage groups (*F*s = 0.02 – 2.93, *p*s > .10). The following assumptions were tested, (a) independence of observations, (b) normality, and (c) sphericity. Independence of observations and sphericity were met. As discussed previously, reaction times were initially positively skewed with the majority of scores greater than 1. After Winsorizing the scores, time 1 reaction time skew scores ranged from 0.46 – 1.13. Reaction times were not further transformed due to robustness of this test against violations of normality.

For the 175ms stimulus duration trials, there was a significant expression x congruency interaction, (F (1, 39) = 4.31, p = .04, η_p^2 = .10), though main effects for both expression (F (1, 39) < 1, p = .39, η_p^2 = .02) and congruency (F (1, 39) = 1.66, p = .21, η_p^2 = .04) were non-significant. The interaction is explained by slower times to respond to probes replacing angry faces (M = 491) compared to probes opposite the angry face (M = 489). Though the difference was not significant (t (40) = 0.61, p = .55), it suggests a trend in bias in attention *away* from angry faces at a 175ms stimulus duration. Response times did not differ between probes replacing happy faces (M = 489) and probes opposite the happy face (M = 490), (t (40) = 0.34, p = .73).

For 600ms stimulus duration trial, main effects for both expression (F (1, 39) < 1, p = .42, η_p^2 = .02) and congruency (F (1, 39) < 1, p = .62, η_p^2 = .006) were non-significant. The expression x congruency interaction was also non-significant, F (1,39) < 1, p = .62, η_p^2 = .006. As such, there was no indication of attention bias with either angry or happy faces at 600ms.

Overall bias scores for happy and angry faces at 175ms and 600ms are presented in Table 3. Bias scores for angry faces indicated trends for attention *away* from angry faces at 175ms (-1.95, *SD* = 20.69) and *toward* angry faces at 600ms (4.73, *SD* = 21.92). The opposite pattern emerged with happy faces, with trends for biases *toward* happy faces at 175ms (1.15, *SD* = 21.45) and *away* from happy faces at 600ms (-3.51, *SD* = 20.27). However, none of these bias scores differed significantly from 0 (0 indicates equivalent response times between probes replacing emotional faces and neutral faces, and thus, no bias in attention), indicating no significant biases in attention (*t*s = .34 – 1.38, *p*s = .18 - .73).

Relationship with social anxiety. In order to assess relationships with biased attention in relation to social threat (angry faces) and both trait and state levels of social anxiety, bias scores were correlated with both the total LSAS score and the state social anxiety score completed just prior to the first dot probe task (see Table 3). No significant relationships emerged either at 175 ms (LSAS total : r = -.15, p = .34; SSA: r = -.17, p = .30) or 600ms (LSAS total : r = -.01, p = .98; SSA: r = .05, p = .75). There were also no significant relationships between overall bias scores and the LSAS avoidance score (175 ms: r = -.18, p = .25; 600ms: r = -.09, p = .78), or heart rate (175 ms: r = -.15, p = .38; 600ms: r = .12, p = .46).

Finally, 10 participants had scores on the LSAS above 30, indicative of clinical levels of social anxiety (Mennin, Fresco, Heimberg, Schneier, Davies, & Liebowitz, 2002). *Post hoc* analyses in which the above analyses were repeated with only this subsample yielded a significant expression x congruency interaction at 175ms, suggestive of attentional bias (*F* (1, 9) = 5.34, *p* = .05, η_p^2 = .37). Follow-up analyses of this interaction indicated a significantly slower reaction times to probes replacing the angry face (*M* = 500ms) than to probes replacing the neutral face (*M* = 488ms; *t*(9) = 2.69, *p* = .03), indicating biased attention *away* from angry faces. There were no significant difference in reaction times to probes replacing the happy face (*M* = 486) compared to probes replacing the neutral face (*M* = 493), *t*(9) = 0.86, *p* = .41. Analysis of bias scores at 175ms also yielded a significant main effect of expression (*F* (1, 9) = 5.34, *p* = .05, η_p^2 = .37), such that attention was biased away from angry faces (*M* = -11.87, *SD* = 4.41) and toward happy faces (*M* = 6.54, *SD* = 7.63). Single-sample *t*-tests indicate that the bias away from angry faces was significantly different from 0, (*t* (9) = 2.69, *p* = .03), though the bias toward happy faces did not reach significance (*t*(9) = 0.86, *p* = .41).

Analyses for this subsample at 600ms also indicated a significant face x congruency interaction (*F* (1, 9) = 18.88, *p* = .002, η_p^2 = .68), suggestive of attention bias. Follow-up analysis of this interaction yielded faster responses to probes replacing angry faces (*M* = 488) than to probes replacing neutral faces (*M* = 498; *t* (9) = 3.15, *p* = .01). Responses to probes replacing happy faces (*M* = 488) showed a trend for these responses to be slower than responses to probes replacing the neutral face (*M* = 481), but the difference did not reach significance, *t* (9) = 1.88, *p* = .09. Analysis of bias scores at 600ms indicated a significant main effect for expression (*F* (1, 9) = 18.88, *p* = .002, η_p^2 = .68), such that attention was biased *toward* angry faces (*M* = 10.46, *SD* = 3.32) and away from happy faces (*M* = -6.88, *SD* = 3.65). Single sample *t*-tests indicated that the bias toward angry faces significantly differed from 0, ($t(9) = 3.15$, $p = .01$), though the bias away from happy faces did not reach significance, $t(9) = 1.88$, $p = .09$.

1b. Attentional Bias Following Beverage Consumption

A 2 (expression: happy, angry) x 2 (congruency: congruent, incongruent) x 2 (beverage: alcohol, control) repeated-measures ANOVA, with expression and congruency as within-subjects variables, beverage condition as a between-subjects variable, and reaction times as the dependent variable, conducted separately for 175ms and 600ms stimulus durations. The following assumptions were tested, (a) independence of observations, (b) normality, and (c) sphericity. Independence of observations and sphericity were met. As discussed previously, reaction times were initially positively skewed with the majority of scores greater than 1. After Winsorizing the scores, time 2 reaction time skew scores ranged from -0.83 – 1.62, with the majority of scores from 0-1. Reaction times were not further transformed due to robustness of this test against violations of normality.

For the 175ms stimulus duration, the 2 (expression) x 2 (congruency) x 2 (beverage) repeated-measures ANOVA indicated that there was a significant main effect for beverage condition (F (1, 39) = 6.41, $p = .02$, $\eta_p^2 = .14$), such that there were slower overall reaction times in the alcohol condition (M = 473ms) than in the control condition (M = 433ms). The three-way interaction was not significant, (F (1, 39) < 1, $p = .66$, $\eta_p^2 = .005$), nor were any two-way interactions. Planned follow-up analyses for each of the beverage conditions indicated no significant expression x congruency interactions that would indicate attentional biases for either the control condition (*F* (1, 18) < 1, *p* = .55, η_p^2 = .02) or the alcohol condition (*F*(1, 21) < 1, *p* = .91, η_p^2 = .001).

For the 600ms condition, the 2 (expression) x 2 (congruency) x 2 (beverage) repeated-measures ANOVA indicated that the three-way interaction was not significant (*F* (1, 39) < 1, *p* = .40, η_p^2 = .02). There were no significant overall differences between the alcohol and control conditions (*F*(1, 39) = 1.68, *p* = .20, η_p^2 = .04), nor any other main or interaction effects. Planned follow-up analyses for each of the beverage conditions indicated no expression x congruency interactions that would indicate attentional biases for either the control condition (*F* (1, 18) = 1.70, *p* = .21, η_p^2 = .09) or the alcohol condition (*F* (1, 21) < 1, *p* = .81, η_p^2 = .003). In the alcohol condition, the main effect for congruency approached significance (*F* (1, 21) = 3.39, *p* = .08, η_p^2 = .14), such that reaction times were faster to probes that replaced the angry or happy faces (congruent: *M* = 452ms) compared to probes opposite the angry or happy faces (incongruent: *M* = 457ms).

As planned follow up analyses, 2 (facial expression: angry, happy) x 2 (beverage condition: alcohol, control) repeated-measures ANOVAs were conducted for each of the stimulus durations (175 ms, 600ms) using bias scores as the dependent variable to test if bias scores changed over the course of the second dot probe task, with facial expression as within-subject variables, and beverage condition as a between-subjects variable.

For the 175ms stimulus duration, there was no significant expression x beverage condition interaction (*F*(1, 39) < 1, *p* = .66, η_p^2 = .005), nor any main effects for beverage condition (*F* (1, 39) < 1, *p* = .90, η_p^2 < .001) or expression (*F* (1, 39) < 1, *p* = .79, η_p^2 = .002). Planned follow-up analyses for each of the beverage conditions yielded no significant differences in bias scores between angry and happy faces for either the control condition (*F* (1, 18) < 1, *p* = .55, η_p^2 = .02) or the alcohol condition (*F* (1, 21) < 1, *p* = .91, η_p^2 = .001). For the control condition, bias scores for neither the happy face (*M* = 1.03, *SD* = 17.76; *t*(18) = .025, *p* = .80) or the angry face (*M* = -2.04, *SD* = 15.68; *t*(18) = 0.57, *p* = .58) differed significantly from zero. In the alcohol condition, bias scores for neither the happy face (*M* = -0.32, *SD* = 22.50; *t*(21) = .07, *p* = .95) or the angry face (*M* = 0.40, *SD* = 21.69; *t*(21) = 0.09, *p* = .93) differed significantly from zero (see Table 3).

For the 600ms stimulus duration, there was no significant expression x beverage condition interaction (*F* (1, 39) < 1, *p* = .40, η_p^2 = .02), nor any significant main effects for either beverage condition (*F* (1, 39) < 1, *p* = .41, η_p^2 = .02), or expression (*F* (1, 39) = 1.37, *p* = .25, η_p^2 = .03). Planned follow-up analyses for each of the beverage conditions yielded no significant differences in bias scores between angry and happy faces for either the control condition (*F* (1, 18) = 1.70, *p* = .21, η_p^2 = .09) or the alcohol condition (*F* (1, 21) < 1, *p* = .81, η_p^2 = .003). For the control condition, bias scores for neither the happy face (*M* = -2.43, *SD* = 18.59; *t*(18) = .57, *p* = .58) or the angry face (*M* = 6.03, *SD* = 19.62; *t*(18) = 1.34, *p* = .20) differed significantly from zero. In the alcohol condition, bias scores for neither the happy face (*M* = 4.57, *SD* = 15.58; *t*(21) = 1.38, *p* = .18) nor the angry face (*M* = 5.91, *SD* = 20.81; *t*(21) = 1.33, *p* = .20) differed significantly from zero (see Table 3).

Relationship with social anxiety. In order to assess relationships with biased attention in relation to social threat (angry faces) and both trait and state levels of social anxiety, bias scores were correlated with both the total LSAS score and the state social anxiety score completed after beverage consumption and just prior to the second dot probe task (see Table 3). There were no significant relationships between bias scores and social anxiety measures in the control condition at either 175ms (LSAS total : $r = .34$, $p = .15$; LSAS avoidance: $r = .40$, $p = .09$; SSA: $r = -.004$, $p = .99$; heart rate: $r = -.04$, $p = .87$) or 600ms (LSAS total : $r = -.11$, $p = .65$; LSAS avoidance: $r = -.04$, $p = .86$; SSA: $r = -.36$, $p = .14$; heart rate: $r = .12$, $p = .64$). There were also no significant relationships between bias scores and social anxiety measures for those in the alcohol condition at either 175ms (LSAS total : $r = .08$, $p = .72$; LSAS avoidance: $r = .13$, $p = .78$; SSA: $r = .05$, $p = .81$; heart rate: $r = .06$, $p = .83$) or 600ms (LSAS total : $r = .16$, $p = .49$; LSAS avoidance: $r = .17$, $p = .45$; SSA: $r = -.22$, $p = .32$; heart rate: $r = .29$, $p = .26$).

Six individuals in the control condition (2 female) and four individuals in the alcohol condition (3 female) had scores on the LSAS indicative of clinical levels of social anxiety. Given the small sample size, non-parametric tests were conducted to explore the presence of attentional bias to threat in this subsample. The presence of significant attentional bias was determined by comparing the median of overall bias scores to 0 (indicating no bias in attention toward or away), using a one-sample Wilcoxon signed ranks test. Results indicated that for the alcohol condition, median bias scores were not significantly different from 0 at 175ms for angry faces (*Median* = 1.05, *SD* = 2.74, $p = 1.00$, $r^2 = 0.00$). For happy faces at 175ms, there was a trend toward a bias toward happy faces which did not reach statistical significance, but did evidence a large effect size based on standards by Cohen (1988) (*Median* = 9.35, *SD* = 2.74, p = .27, r^2 =.30). At 600ms, those in the alcohol condition evidenced a non-significant bias toward angry faces (*Median* = 3.60, *SD* = 2.74, p = .14, r^2 = .53) and no apparent bias in regards to happy faces (*Median* = -0.95, *SD* = 2.74, p = 1.00, r^2 = 0.00).

For the control condition, one-sample Wilcoxon signed ranks tests indicated that at 175ms there was no apparent bias in relation to either angry faces (*Median* = -6.51, *SD* = 4.77, p = .92, r^2 = .002) or happy faces (*Median* = -0.59, *SD* = 4.77, p = .92, r^2 = .002). At 600ms, however, there was a significant bias *toward* angry faces (*Median* = 11.85, *SD* = 4.77, p = .03, r^2 = .81) and no apparent bias toward happy faces (*Median* = 0.82, *SD* = 4.77, p = .92, r^2 = .002).

A Mann-Whitney U test was conducted to see if overall bias scores differed between control and alcohol conditions. For angry faces, it appears as if distributions of bias scores for the alcohol and control groups did not differ at 175ms (p = .83) or 600ms (p = .29). Nor did the distributions of bias scores differ for happy faces in either the 175ms (p = .52) or 600ms stimulus conditions (p = .83).

Change in reaction times from pre- to post-beverage consumption. A 2 (beverage condition: alcohol, control) x 2 (facial expression: angry, happy) x 2 (time: pre-beverage, post-beverage) ANOVA was conducted on bias scores for each of the two stimulus durations (175ms, 600ms). Beverage condition was the between-subjects variable, while facial expression and time were within-subjects variables.

For 175ms stimulus duration, the three-way beverage condition x expression x time interaction was not significant, $F(1, 39) < 1$, $p = .44$, $\eta_p^2 = .02$. No significant main effects or interactions emerged. Though the beverage conditions did not significantly differ (F (1, 39) < 1, $p = .86$, $\eta_p^2 = .001$), planned follow-ups were conducted for each of the alcohol and control conditions to test patterns of change in attention for each condition. In the alcohol condition, there was no significant interaction for expression x time ($F(1, 21) < 1$, $p = .46$, $\eta_p^2 =.03$). There were no significant differences between angry faces prior to beverage consumption ($M = -2.69$, $SD = 24.78$) and after beverage consumption ($M = 0.40$, $SD = 21.69$; $t(21) = 0.46$, $p = .65$); nor happy faces prior to beverage consumption ($M = 2.58$, $SD = 18.57$) and after beverage consumption ($M = -0.32$, $SD = 22.50$; $t(21) = 0.52$, $p = .61$). In the control condition, there was also no significant expression x time interaction ($F(1, 18) < 1$, $p = .73$, $\eta_p^2 = .01$). There were no significant differences between angry faces prior to beverage consumption ($M = -1.11$, $SD = 15.30$) and after beverage consumption ($M = -2.04$, $SD = 15.68$; $t(18) = 0.21$, $p = .84$); nor happy faces prior to beverage consumption ($M = -0.51$, $SD = 24.80$) and after beverage consumption ($M = 1.03$, $SD = 17.76$; $t(18) = 0.23$, $p = .82$).

For the 600ms stimulus duration, the three-way interaction between beverage condition x expression x time was not significant, $F(1, 39) = 1.15$, $p = .29$, $\eta_p^2 = .03$. There was a significant main effect for expression, such that there was a bias toward angry faces ($M = 5.32$, $SE = 2.15$) and away from happy faces ($M = -1.15$, $SE = 2.34$; F (1, 39) = 4.73, $p = .04$, $\eta_p^2 = .11$). Though the alcohol and control conditions did not differ ($F(1, 39) < 1$, $p = .73$, $\eta_p^2 = .003$), planned follow-up analyses were conducted for each condition. In the alcohol condition, the expression x time interaction was not significant (F(1, 21) = 2.04, p = .17, η_p^2 = .09). There were no significant differences between angry faces prior to beverage consumption (M = 5.53, SD = 21.91) and after beverage consumption (M = 5.91, SD = 20.81; t(21) = 0.06, p = .95). However, there was a significant change in attention to happy faces following alcohol consumption, from a bias away from happy faces before drinking alcohol (M = -5.36, SD = 20.08) to a bias toward happy faces after drinking alcohol (M = 4.57, SD = 15.58; t(21) = 2.42, p = .03). In the control condition, there was no significant expression x time interaction, F(1, 18) < 1, p = .75, η_p^2 = .01. There were no significant differences between angry faces prior to beverage consumption (M = 3.81, SD = 22.50) and after beverage consumption (M = 6.03, SD = 19.62; t(18) = 0.27, p = .79); nor happy faces prior to beverage consumption (M = -1.38, SD = 20.83) and after beverage consumption (M = -2.43, SD = 18.59; t(18) = 0.17, p = .86).

Relationship with social anxiety. In order to assess how changes in attention bias related to both state and trait social anxiety, the difference in bias scores (Pre beverage – post beverage) were calculated and correlated with the total LSAS score and LSAS avoidance subscale, as well as difference scores (pre-beverage – post beverage) for state measures of social anxiety (SUDS , SSA, and heart rate). The correlation table is shown in Table 4. As reported above, though not significant, the control condition evidenced an increased bias in attention *away* from angry faces at 175ms from pre- to post- beverage consumption, and this was negatively correlated with measures of trait social anxiety, both overall (LSAS total r = -.63, p = .004) and trait social avoidance (LSAS avoidance: r

= -.68, *p* = .002). At the 600ms duration for angry faces, those in the control condition also showed a significant negative correlation with changes in state social anxiety (*r* = -.55, *p* = .01). Among those in the alcohol condition, there was a negative correlation between changes in attention to angry faces at 175ms and change in SUDS from pre- to post beverage consumption (*r* = -.60, *p* = .003). There were no significant relationships between changes in biases to angry faces and changes in heart rate for either the alcohol (175ms: *r* = -.12, *p* = .65; 600ms: *r* = .18, *p* = .49) or control (175ms: *r* = .19, *p* = .47; 600ms: *r* = -.36, *p* = .15) conditions.

Examination of those individuals reporting scores in the clinical range for social anxiety on the LSAS was conducted using Friedman's Two-Way Analysis of Variance by Ranks to determine if there were any time (2: pre-beverage, post-beverage) x expression (2: happy, angry) interactions for individuals in either the control (*n* = 6) or alcohol conditions (*n* = 4). The interactions were non-significant for both the control (*p* = .46) and the alcohol (*p* = .13) conditions.

2. Dot Probe as a Measure of Attention

Reliability. Internal consistency of the dot probe task was calculated by determining both split-half reliability and Cronbach's alpha (Schmukle, 2005; Staugaard, 2009). Split-half reliability was calculated by correlating the mean bias score of the first two blocks of trials with the mean bias score of the second two blocks of trials, for each dot probe presentation (pre- and post-beverage consumption), face expression (angry, happy), and stimulus duration (175ms, 600ms). All split-half correlations were lower than

$r = .36$, and all ps $> .10$. Cronbach's alpha was calculated following procedures from Schmukle (2005) and Staugaard (2009). The 64 critical trials for each expression x stimulus duration x presentation time were randomly paired to have one congruent and one incongruent trial. A bias score was calculated for each of these 32 incongruent-congruent pairings. Missing data was accounted for using linear regression multiple imputations, with 5 imputations. The average of the Cronbach's alpha scores across the five imputation models is presented in Table 3. All Cronbach's alpha scores were insufficient, with several negative values, and all values below 0.48. Negative Cronbach alpha scores are uninterpretable, and are the result of a negative average covariance between the items (Nichols, 1999). Staugaard (2009) similarly reported negative Cronbach alphas.

Validity. The relationship between bias scores and state and trait measures of social anxiety has been discussed throughout and are reported in Tables 3 and 4. Table 3 depicts individual correlations with bias scores for each of the beverage conditions, pre- and post- beverage conditions, and stimulus durations. Prior to beverage consumption, there was no significant relationship with bias scores and trait social anxiety (as measured by the total score on the LSAS) and state social anxiety (as measured by the state social anxiety measure and SUDS ratings completed immediately prior to the beginning of the dot probe task). After consuming alcohol, there remained no significant relationships between bias scores and state and trait social anxiety measures. For individuals in the control condition, there were only significant relationships between state anxiety measures and happy faces. At 175ms, there was a significant negative relationship between bias scores to happy faces (r = -.57, p = .01), such that as state social anxiety (SSA) increased, individuals demonstrated greater biases in attention away from happy faces. At 600ms, the trend was reversed, such that those with higher levels of state anxiety (SUDS) were likely to attend to happy faces (r = .48, p = .04).

Table 4 depicts findings regarding changes between the pre- and post-beverage consumption biases in attention and trait anxiety (total LSAS and the avoidance LSAS subscore) and changes in state anxiety (including SSA, SUDS, and heart rate). In the control condition, there were significant negative relationships between changes in responding to angry faces at 175ms and measures of both overall trait social anxiety (LSAS total: r = -.63, p = .004) and trait avoidance of social situations (LSAS avoidance: r = -.68, p = .002). Those with higher scores on both measures of trait social anxiety showed greater degrees of avoidance of angry faces at 175ms during the second dot probe task. A similar relation held for control participants with changes in state social anxiety (SSA) showing a significant negative correlation with change in biases to angry faces at 600ms (r = -.55, p = .01). That is, for individuals who become more socially anxious from the first dot probe to the second dot probe, attention to angry faces at 600ms decreases. For those in the alcohol condition, there was only a significant negative relationship between changes in biases to angry faces at 175ms and changes in state anxiety (SUDS: r = -.60, p = .003). That is, as state anxiety increased following the alcohol administration, attention away from angry faces decreased. There were no significant relationships with any of the bias scores for either the control or alcohol conditions and changes in mean heart rate.

Habituation.

Pre-beverage**.** In order to assess overall changes in attention bias to social threat during the dot probe task completed prior to beverage consumption, separate 2 (expression: angry, happy) x 2 (congruency: congruent, incongruent) x 4 (blocks 1-4) repeated-measures ANOVAs were calculated for each stimulus duration (175ms and 600ms), with expression, congruency, and blocks all serving as within-subjects variables. Because data were removed from one participant each in the fourth block of time 1 and time 2, these expression x congruency x block analyses only included those 40 participants for whom all data were preserved. The assumption of sphericity was violated for block in all analyses, and the Greenhouse-Geisser correction was used for the main effect of block and all interaction effects with block included.

For stimulus presentation times of 175ms, the results indicated no significant expression x congruency x block interaction (F (3, 114) = 1.36, p = .26, η_p^2 = .04), nor any significant main effects of block (F (3, 114) = 1.30, p = .28, η_p^2 = .03), or interactions with block x expression (F (3, 114) < 1, p = .71, η_p^2 = .01) or block x congruency (F (3, 114) = 1.39, p = .25, η_p^2 = .04). For stimulus duration of 600ms, the results indicated no significant expression x congruency x block interaction (F (3, 114) < 1, p = .54, η_p^2 = .02), nor any significant main effects of block (F (3, 114) < 1, p = .71, η_p^2 = .01), or interactions with block x expression (F (3, 114) < 1, p = .50, η_p^2 = .02) or block x congruency (F (3, 114) = 2.11, p = .12, η_p^2 = .05).

As planned follow up analyses, a 4 (block) x 2 (facial expression: angry, happy) repeated-measures ANOVAs were conducted for each of the stimulus durations (175 ms, 600ms) using bias scores as the dependent variable to test if bias scores changed over the course of the first dot probe task, with both block and facial expression as within-subject variables.

For the 175ms stimulus duration, both the main effect for block (F (3, 114) = 1.50, p = .22, η_p^2 = .04) and the expression x block interaction (F (3, 114) = 1.70, p = .18, η_p^2 = .04) were non-significant. As seen in Figure 3, the pattern indicates a bias away from angry faces and toward happy faces during the first two blocks. By the third block, the pattern switches, with a bias toward angry faces and away from happy faces, before reaching a similar response for both face types by block 4. Single-sample *t*-tests comparing each bias score with 0 indicated no significant differences from 0 with any of the bias scores from any of the block x expression permutations (*t*s = 0.19 – 1.36, *p*s = .18 - .83).

For the 600ms stimulus duration, the expression x block interaction did not reach significance (F(3, 114) < 1, p = .54, η_p^2 = .02), nor did main effects for expression (F (1, 38) < 1, p = .56, η_p^2 = .009) or block (F (3, 114) = 2.11, p = .12, η_p^2 = .05). As seen in Figure 4, the pattern indicates an initial bias toward angry faces in Block 1, but similar responses to both angry and happy faces over the remaining blocks. Single-sample *t*-tests comparing each bias score with 0 (representative of no bias in attention toward or away from an angry or happy face) indicates that bias toward angry faces in Block 1 approaches significance (t(40) = 1.87, p = .07), though bias scores for angry faces in Blocks 2-4 did not (ts = 0.14 – 1.57, ps = .13 - .89). Bias scores for happy faces indicated attention away from happy faces in Blocks 1-3, and toward happy faces in Block 4, though none of the bias scores approached significant differences from 0 (ts = .39 – 1.44, ps = .16 - .70).

Post-beverage. In order to assess changes in attention bias to social threat across the dot probe task following beverage consumption, separate 2 (expression: angry, happy) x 2 (congruency: congruent, incongruent) x 2 (beverage condition: alcohol, control) x 4 (blocks 1 -4) repeated-measures ANOVAs were calculated for each stimulus duration (175ms and 600ms), with expression, congruency, and blocks all serving as within-subjects variables, and beverage condition as a between-subjects variable. Because data were removed from one participant each in the fourth block of time 2, these expression x congruency x beverage x block analyses only included those 40 participants for whom all data were preserved. The assumption of sphericity was violated for block, and the Greenhouse-Geisser correction was used for the main effect of block and all interaction effects with block included.

For the 175ms stimulus duration, the 2 (expression) x 2 (congruency) x 2 (beverage) x 4 (block) repeated-measures ANOVA yielded a significant main effect for block (F (3, 114) = 16.18, p < .001, η_p^2 = .30), such that reaction times during the first block (M = 431) were significantly faster than the other three blocks, which did not differ from each other (Ms = 454-462). There was also a significant main effect for beverage condition (*F* (1, 38) = 5.47, *p* = .03, η_p^2 = .13), such that responses were slower in the alcohol condition (*M* = 470) than in the control condition (*M* = 433). The main four-way expression x congruency x beverage x block interaction was not significant, *F* (3, 114) = 1.20, *p* = .31, η_p^2 = .03, nor were any other interactions significant.

For the 600ms stimulus duration, the 2 (expression) x 2 (congruency) x 2 (beverage) x 4 (block) repeated-measures ANOVA yielded a significant main effect for block (*F* (3, 114) = 5.91, *p* = .002, η_p^2 = .14), such that reaction times were significantly faster during the first block (*M* = 433ms) than blocks 2-4 (*M*s = 446-449ms), with no differences between the last 3 blocks. The main effect for congruency approached significance (*F* (1, 38) = 3.76, *p* = .06, η_p^2 = .09), with individuals responding faster to congruent trials (where the probe replaced either the happy or angry face; *M* = 442, *SD* = 7.48) than to incongruent trials (where the probe appeared opposite the happy or angry face; *M* = 446, *SD* = 8.00), suggestive of attention biased toward emotional faces. However, the congruency x expression interaction was not significant, *F* (1, 38) = 1.23, *p* = .28, η_p^2 = .03. Nor was the expression x congruency x beverage x block interaction, *F* (3, 11) < 1, *p* = .80, η_p^2 < .01.

As planned follow-up analyses, a 4 (block) x 2 (facial expression: angry, happy) x 2 (beverage condition: alcohol, control) repeated-measures ANOVAs were conducted for each of the stimulus durations (175 ms, 600ms) using bias scores as the dependent variable to test if bias scores changed over the course of the first dot probe task, with both block and facial expression as within-subject variables, and beverage condition as a between-subjects variable.

For 175ms, the overall 4 (block) x 2 (expression) x 2 (beverage) interaction was not significant (F (3, 114) = 1.20, p = .31, η_p^2 = .03). Nor were there any significant main effects for beverage condition (F (1, 38) < 1, p = .84, η_p^2 = .001), expression (F (1, 38) < 1, p = .43, η_p^2 = .02), or block (F (3, 114) = 1.82, p = .15, η_p^2 =.05), or any significant interactions. Planned analyses by beverage condition indicate no significant differences for either alcohol or control conditions in bias scores by expression (control: F (1, 18) < 1, p = .55, η_p^2 = .02; alcohol: F (1, 20) < 1, p = .59, η_p^2 = .02) or expression x block interactions (control: F (3, 54) = 1.63, p = .20, η_p^2 = .08; alcohol: F (3, 60) = 1.66, p = .19, η_p^2 = .08). Single-sample *t*-tests comparing each of the bias scores with 0 indicated that no bias scores were significantly different from zero for either the control condition (happy: *t*s = 0.04 – 1.66, *p*s = .11 - .97; angry: *t*s = 0.83 – 1.40, *p*s = .18 -.42) or the alcohol condition (happy: *t*s = 0.28 – 1.65, *p*s = .12 - .78; angry: *t*s = 0.17 – 0.79, *p*s = .44 -.87; see Figure 5).

For 600ms, the overall 4 (block) x 2 (expression) x 2 (beverage) interaction was not significant (F (3, 114) < 1, p = .80, η_p^2 < .01). Nor were there any significant main effects for beverage condition (F (1, 38) = 1.12, p = .30, η_p^2 = .03), expression (F (1, 38) = 1.23, p = .28, η_p^2 = .03), or block (F (3, 114) = 1.04, p = .37, η_p^2 =.03), or any significant interactions. Planned analyses by beverage condition indicate no significant differences for either alcohol or control conditions in bias scores by expression (control:

F (1, 18) = 1.70, *p* = .21, η_p^2 = .09; alcohol: *F* (1, 20) < 1, *p* = .86, η_p^2 < .01) or expression x block interactions (control: *F* (3, 54) < 1, *p* = .78, η_p^2 = .02; alcohol: *F* (3, 60) < 1, *p* = .92, η_p^2 < .01). Comparisons of expression x beverage bias scores with 0 in single-sample *t*-tests to examine significant biases for attention indicated no significant biases in either the control (happy: *M* = -2.43, *SD* = 18.59, *t* (18) = 0.57, *p* = .58; angry: *M* = 6.03, *SD* = 19.62, *t* (18) = 1.34, *p* = .20) or alcohol (happy: *M* = 4.57, *SD* = 15.58, *t* (21) = 1.38, *p* = .18; angry: *M* = 5.91, *SD* = 20.81, *t* (21) = 1.33, *p* = .20) conditions (see Figure 6).

Discussion

The present study marks the first empirical examination of hypotheses posed in the Avoidance-Coping Cognitive model (Bacon & Ham, 2010). Specifically, we attempted to replicate findings regarding attentional biases to social threat (Garner et al., 2006; Mogg & Bradley, 2002), and tested whether biases toward threat would decrease following moderate alcohol consumption (Stevens et al., 2009). Overall, results indicated that we were not able to replicate biases in attention toward angry faces (social threat cue) prior to alcohol consumption, at either early (175ms) or late (600ms) stages of attentional processing. After alcohol consumption, there appeared to be a change in attention to *happy* but not angry faces at later stages of processing, such that individuals had a tendency to attend away from happy faces before drinking alcohol, but toward happy faces after drinking alcohol. Alcohol did not appear to affect attentional biases at earlier stages of processing, as predicted. Finally, another aim of the study was to examine the psychometric properties of the dot probe task. Though the dot probe task is a standard and commonly used method for assessing attentional biases, very little has been published about the reliability and validity of the task. The results of the present study join others (Schmukle, 2005; Staugaard, 2009) that find little support for the reliability and validity of the dot probe task.

1a. Attention to Social Threat

The Avoidance-Coping Cognitive model (Bacon & Ham, 2010) has as its initial premise that there is a bias in attention to social threat under conditions of sobriety (Garner et al., 2006; Mogg & Bradley, 2002). It further contends that this bias is potentiated in individuals with social anxiety, such that they are more likely to 1) demonstrate a biased attentional preference *toward* social threat cues at initial stages of information processing (Mogg & Bradley, 2002), and 2) show a bias in attention *away* from social threat cues at later stages of processing, as a means of avoiding anxiety-inducing cues (Chen et al., 2002; Mansell et al., 1999). In the present study, we were not able to replicate these findings in the overall sample. That is, reaction times to probes replacing angry faces and those replacing neutral faces were virtually similar at both 175ms and 600ms stimulus presentations. Calculation of bias scores—which provide a metric of degree and direction of bias—also supports that biases to both angry and happy faces did not differ significantly from zero, indicating no bias.

While the present results did not support hypotheses, there is evidence in the literature and in the present data that provides potential explanation and helps in developing plans for future studies. Though there is robust support for evidence of attentional biases in anxiety disorders generally (Bar-Haim et al., 2007), there are some studies that have been unable to replicate this effect. Gotlib and colleagues (2004) found no evidence of biases in attention to angry faces in either clinically socially anxious or non-clinical control groups, though they did find evidence of biases in attention to sad faces among individuals diagnosed with major depression. Similarly, Pineles and Mineka (2005) found no evidence of bias in attention toward photographs of threatening faces in individuals with high or low social anxiety. They were able to demonstrate that those with high social anxiety showed an attentional bias toward a cue indicating internal anxiety (e.g., cues representing heart rate). In addition, it can be reasonably expected that there may be other data that evidence of null results that may have not made it into the published literature.

There have been more consistent findings of biases in attention to social threat in individuals with clinical or sub-clinical levels of social anxiety (Bögels & Mansell, 2004). To that extent, our findings provide partial replication of this effect. In those individuals who endorsed clinical levels of social anxiety on a standardized self-report measure (n = 10), there was evidence of biases in attention to social threat, though in the opposite direction than predicted. Specifically, among individuals with higher levels of social anxiety, attention was biased *away* angry faces at 175ms, and *toward* angry faces at 600ms. The opposite was true for happy faces: there was a bias *toward* happy faces at 175ms and *away* from happy faces at 600ms. What this seems to reflect is an automatic preference for happy faces and avoidance of cues signaling anger. However, when engaging in more controlled processing of information, there is a preference to attend to threat cues. This pattern is contrary to that proposed by the vigilance-avoidance hypothesis (Amir & Foa, 2001; Ledley & Heimberg, 2006). It is worth noting however, that the dot probe task represents only a “snapshot” of attentional allocation—where attention was on the screen at 175ms and 600ms, and may not reflect more nuanced patterns of shifting attention that may be observed with eye-tracking devices (Mühlberger, Wieser, & Pauli, 2008).

Should the above results be an accurate reflection of the phenomenology of attention to social threat in non-selected individuals and a subsample of those with clinically relevant social anxiety, this would warrant some modification to the existing Avoidance-Coping Cognitive model. First, the model is currently intended to explain pathways by which *any* individual may be susceptible to using alcohol to modify anxiety in social situations. It proposes that individuals with elevated levels of social anxiety or social anxiety disorder may experience greater anxiolytic effects—and thus greater reinforcement from alcohol use--due to initially exacerbated biases in attention to social threat. To the extent that non-anxious individuals demonstrate no apparent automatic or controlled visual attention preference either toward or away from angry faces, the anxiolytic effect of alcohol in these individuals may manifest through different cognitive or physiological pathways.

Secondly, the present findings suggest that socially anxious individuals show automatic biases in attention away from angry faces in earlier stages of processing and biases toward angry faces during more controlled processing—the opposite of that predicted by the Avoidance-Coping Cognitive model. This would suggest initial cognitive avoidance, though later vigilance toward signals of potential threat. The current limited research base on the effects of alcohol on visual attention suggests that alcohol impairs controlled processing of unpleasant or negative stimuli, but not neutral or pleasant stimuli (Franken et al., 2007). If alcohol does primarily affect controlled information processing and anxious individuals preferentially attend to social threat during controlled processing, then the present findings would still continue to predict that alcohol use would disrupt the processing of threatening cues and provide a decrease in anxiety.

1b. Changes in Attentional Biases Following Alcohol Consumption

The Avoidance-Coping Cognitive model predicted that individuals consuming alcohol would experience a disruption in cognitive processing, including attentional biases toward cues of social threat. Thus, we predicted that those individuals who consumed a moderate dose of alcohol in the present study would evidence a decreased bias toward social threat cues, to the extent that attention toward angry faces and neutral faces would be roughly similar. A control group of individuals who did not consume alcohol similarly completed two dot probe tasks, in order to ensure that changes in biases in attention were not due to time or practice effects.

When examining the post-beverage consumption data alone, results indicated a predictable slower reaction time to identify the location of the probe among those in the alcohol condition compared to the control condition, though only when the faces were presented for 175ms. These results are similar to findings by Franken and colleagues (2007), where individuals consuming alcohol demonstrated overall slower automatic processing for stimuli regardless of valence, but impairments in controlled processing only for negatively-valenced stimuli. Unlike Franken et al., (2007), the present results indicated a non-significant trend for those in the alcohol condition to show biases in controlled attention (presentation times of 600ms) toward both emotional faces (angry and happy) when paired with a neutral expression. Thus, it would seem that those consuming alcohol may demonstrate an attentional preference to any indication of emotion—positive or negative—during controlled processing. As will be discussed later, this preference toward emotion is best explained by comparing changes in attention from pre- to post-beverage, as it appears as if alcohol produced a change in attention to happy faces, but had no effect on attention to angry faces.

Though the social anxiety levels of participants in the current study was analyzed post-hoc, and not included as a factor in random assignment to beverage groups, there was roughly equal representation of individuals with high social anxiety in both the control ($n = 6$) and alcohol ($n = 4$) conditions. Individuals with high social anxiety across both beverage groups evidenced a non-significant trend toward a bias in attention to angry facial expressions at 600ms, though there were no differences between beverage conditions. As has been discussed previously, it is possible that detecting differences in attention with the dot probe task may be best accomplished with a clinical or sub-clinical population. This sub-sample was likely too small to detect differences between a control and alcohol condition if differences in attention to social threat do change as a function of alcohol consumption.

Limited empirical research currently exists on the effects of alcohol on attention to negatively valenced stimuli, and the degree to which alcohol may affect attention to threat cues in socially anxious individuals (Franken et al., 2007; Gerlach et al., 2006; Stevens et al., 2009). As predicted, those who consumed a non-alcoholic control beverage demonstrated no significant differences in attention to either happy or angry faces from pre- to post-beverage consumption at either 175ms or 600ms. For those consuming alcohol, we found no differences in attention to either happy or angry faces at 175ms from pre- to post-alcohol consumption. This is consistent with findings about the effects of alcohol on automatic attentional processing more generally (Abroms et al., 2006), though inconsistent with findings suggesting that acute alcohol intoxication resulted in decreased attention to valenced cues at earlier stages of processing in non-selected (Franken et al., 2007) and socially anxious (Gerlach et al., 2006) individuals. At later controlled stages of processing (600ms), there was a significant change in attention to happy faces, but not angry faces. Specifically, there was a trend reflecting a shift from a bias away from happy faces before drinking to a bias toward happy faces after drinking. This may suggest that non-selected individuals who consume alcohol will preferentially attend to signals indicating a positive social interaction. There is evidence supporting impairments in speed of identifying the emotion of a happy face compared to other emotional faces at a similar BAC as that of the current study (Kano et al., 2002). It is possible then that biases in attention toward happy faces were due to impairments in identifying that emotional expression under conditions of moderate intoxication. Given that the current study was unable to replicate findings of an attentional bias to social threat in our non-selected population prior to drinking, it may be understandable that we were not able to detect any differences in attentional processing to angry faces due to alcohol consumption.

2. Dot Probe as a Measure of Attention

One potential explanation for the inability of the current study to replicate an attentional bias to threat may lie in the task used to assess attention, rather than a failure of predictions of the Avoidance-Coping Cognitive model. The dot probe task has been frequently used as a means of assessing attentional biases, and has been primarily used to assess biases to threat in anxiety disorders (Bar-Haim et al., 2007). Despite its widespread use and robust findings in the literature, very little has been done to examine the reliability and validity of the task itself. Two recent studies have found no internal consistency within the dot probe task and no significant relationships between measures of anxiety and biases in attention (Schmukle, 2005; Staugaard, 2009). The present study yielded similar findings, including no evidence of internal consistency and few significant relationships with measures of state or trait anxiety. The evidence of poor internal consistency of the dot probe task indicates that this task is inappropriate to address questions of attentional allocation in a non-selected sample. Staugaard (2009) contends that the dot probe may still be useful in comparisons between a non-anxious and anxious sample, provided that a non-clinical sample consistently finds no evidence of bias. Attentional biases have been a robust finding in clinical and high anxious non-clinical individuals (Bar-Haim et al., 2007), though clearly continued examination of the psychometric properties of the dot probe task within this population are warranted.

Another feature of the dot probe that was examined in the current study was habituation, based on findings by Liu et al. (2006) and Amir, Najmi, and Morrison (2009) that the pattern of biases in attention changed over the course of dot probe task. However, the current findings did not yield any significant differences in patterns of attention across either the first or second dot probe task administrations. Thus, our current findings are similar to those of Staugaard (2009), who found no differences in attention between the first and second half of the dot probe study in a non-selected sample. As with earlier discussion of failure to find biases in attention or internal consistency in a non-selected sample, the inability to detect any differences in patterns of attention across four blocks of stimuli may be due to inconsistencies in attention to threat (or positive) cues in those individuals without pre-existing anxiety.

Limitations and Future Directions

The lack of support for hypotheses suggests a thorough review of those features that can be improved in future studies. First among these may be whether the dot probe should be used as a reliable and valid method of assessing attention, particularly in a non-selected sample. The findings of the current study, as well as others (Schmukle, 2005; Staugaard, 2009), suggest poor internal consistency of the task. Staugaard (2009) suggests that while the dot probe may be a poor measure of within-group differences, that it may still be a viable option for assessing between-group differences, such as those between clinically anxious and non-anxious samples. Other methods of assessing attention to social threat, such as eye-tracking devices, may be preferable as means of testing attention-related hypotheses within the Avoidance-Coping Cognitive model. Though the dot probe has been touted as preferable to the Stroop task as a means of assessing attention, the task does have limitations, including the apparent lack of reliability. Additionally, the task is indirectly assessing visual attention to a screen location for only the moment when the image was removed from the screen—in the present study at 175ms and 600ms. Attention is a more fluid concept, and using an eye-tracking device in addition or instead of the dot probe has been shown to produce more sensitive and robust results (Isaacowitz et al., 2006; Miller & Fillmore, 2010). Using these tasks may also help to isolate whether the Avoidance-Coping Cognitive model would specifically be applicable to only those with clinical social anxiety, or whether it could continue to be used to explain the anxiolytic effect of alcohol on a non-selected population. Should we continue to use the dot probe task—most likely to compare socially anxious vs. non-anxious individuals—there are some changes to methods within the dot probe task as implemented in the current study that should be addressed. One is the fact that despite efforts to reduce the impact of outlying and extreme reaction times through established methods of preparing data (Amir et al., 2009; Fox & Knight, 2005), the variability in reaction times and bias scores were still in excess of those produced by similar studies (Mogg & Bradley, 2002; Mogg et al., 1997). Thus, we may be more confident in these findings if they are replicated using a more precise method of monitoring reaction times, such as precision keyboards or keyboxes (Jarvis, 2010). Another methodological consideration to future dot probe studies in this area may be considering whether angry facial expressions are a valid social threat cue for socially anxious people. Recent studies have found that socially anxious individuals rate disgust faces more negatively than angry faces, and that socially anxious individuals have difficulty in directing attention away from these indications of social threat (Amir et al., 2005; Buckner et al., 2010). Expressions of disgust in peer interactions may be more valid indications of social disapproval or indications that one is embarrassing oneself. By addressing these considerations of appropriate population, task, and stimuli, we will be better able to test hypotheses presented in the Avoidance-Coping Cognitive model in future studies.

Conclusion

The present study was the first to test assumptions proposed in the Avoidance-Coping Cognitive model (Bacon & Ham, 2010) regarding changes in attentional bias to social threat following alcohol consumption. Possibly due to poor internal consistency in the dot probe task, we were unable to replicate existing research finding an attentional bias to social threat prior to alcohol consumption. Following alcohol consumption, there was a trend toward individuals displaying a bias to both angry and happy faces, with pre- to post-beverage analyses suggesting that alcohol resulted in a change in controlled processing toward happy faces. However, the inability to replicate findings regarding an attentional bias to threat under sober conditions, as well as the poor psychometric properties of the dot probe limits the strength of those conclusions regarding the effects of alcohol on attentional processing. The poor reliability of the dot probe measure in the present sample joins growing evidence (Schmukle, 2005; Staugaard, 2009) suggesting that the dot probe task may not be an appropriate task to assess for attentional biases, at least within a non-clinical sample. Future tests of the Avoidance-Coping Cognitive model may employ different methods of assessing attention to threat, such as eye-tracking devices, and may consider whether the model is applicable to a non-clinical population.

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Table 1. Demographic Characteristics by Beverage Condition

	Control *n* = 19	Alcohol *n* = 22
Demographics		
Age, M (SD)	23.2 (2.3)	22.6 (1.8)
% Female	16%	36%
Caucasian	95%	91%
% Employed ≥ 20 hours/week	47%	41%
% Living on campus	5%	27%
% Freshmen (First year)	16%	14%
Alcohol Use, M (SD)		
Alcohol problems, AUDIT (0-40)	6.6 (2.4)	7.1 (3.3)
Age first drink	16.0 (2.7)	16.1 (2.8)
Social Anxiety, M (SD)		
Trait Social Anxiety, LSAS-SR		
Total Fear (0-72)	12.1 (7.7)	8.6 (6.9)
Total Avoidance (0-72)	7.1 (6.3)	7.0 (7.8)
State Social Anxiety (Baseline)		
General anxiety, SUDS (0 - 100)	14.7 (8.7)	14.3 (7.7)
State social anxiety, SSA (1-35)	1.2 (0.3)	1.2 (0.2)
Psychological assessment, M (SD)		
Negative affect, PANAS (10-50)	12.0 (2.7)	11.9 (2.2)

Table 2. Mean reaction times (ms) with standard deviations in parentheses

			Face pair			
			Angry/Neutral		Happy/Neutral	
		Baseline (neutral/neutral)	Angry	Neutral	Happy	Neutral
Pre-Beverage						
175 ms						
	Alcohol	481 (58)	487 (60)	484 (61)	482 (57)	485 (62)
	Control	493 (83)	495 (89)	494 (89)	498 (85)	497 (88)
600 ms						
	Alcohol	473 (55)	472 (53)	477 (56)	473 (55)	468 (53)
	Control	494 (86)	496 (89)	500 (88)	495 (83)	493 (81)
Post-Beverage						
175 ms						
	Alcohol	472 (50)	473 (49)	473 (45)	474 (51)	473 (49)
	Control	433 (57)	436 (56)	434 (54)	429 (59)	430 (61)
600 ms						
	Alcohol	455 (42)	451 (43)	457 (42)	453 (41)	458 (43)
	Control	437 (60)	433 (56)	439 (57)	435 (51)	432 (61)

Table 3. Results for Overall Bias Scores (With Beverage Groups Collapsed at Pre-Beverage)

			Descriptives		Reliability		Correlations			
			M	SD	Split- half (*r*)	Cronbach α	LSAS	SSA	SUDS	Heart rate
Pre-Beverage										
	175ms									
		Angry	-1.95	20.69	0.09	.03	-0.15	-0.17	-0.19	-0.15
		Happy	1.15	21.45	-0.04	-.08	0.17	-0.06	-0.05	-0.20
	600ms									
		Angry	4.73	21.92	0.1	-.10	-0.01	0.05	-0.14	0.12
		Happy	-3.51	20.27	-0.06	.14	0.04	0.01	0.17	-0.01
Post-Beverage										
Control										
	175ms									
		Angry	-2.04	15.68	0.34	-1.51	0.34	-0.32	0.02	-0.04
		Happy	1.03	17.76	0.05	-.12	-0.2	-0.57**	-0.19	0.50*
	600ms									
		Angry	6.03	19.62	0.01	.48	-0.11	0.03	-0.18	0.12
		Happy	-2.43	18.59	-0.15	-.54	-0.12	0.42	0.48*	-0.25
Alcohol										
	175ms									
		Angry	0.40	21.69	-0.14	.20	0.08	-0.23	0.19	0.06
		Happy	-0.32	22.5	0.36	.19	0.16	0.40	-0.03	0.01
	600ms									
		Angry	5.91	20.81	-0.02	.16	0.16	0.24	0.03	0.29
		Happy	4.57	15.58	0.02	-.78	-0.1	-0.17	-0.09	0.01

Note. Single sample t-tests indicated that no bias scores were significantly different from 0 (all $p > .18$). None of the split-half correlations reached significance (all $p > .10$). $*p < .05$, $**p < .01$; LSAS = Liebowitz Social Anxiety Scale; SSA = State Social Anxiety; SUDS = Subjective Units of Distress

Table 4. Correlations Between Differences in Bias Scores (Pre-Beverage minus Post-Beverage) and Trait Social Anxiety and State Social Anxiety Difference Scores (Pre-Beverage minus Post-Beverage).

			LSAS total	LSAS Avoidance	SSA pre - post	SUDS pre - post	Heart rate pre- post
Control							
	175 ms						
		Angry faces (pre - post)	-.63**	-.68**	.31	.18	.19
		Happy faces (pre - post)	.10	.05	-.13	.19	.07
	600 ms						
		Angry faces (pre - post)	.14	.05	-.55*	-.004	-.36
		Happy faces (pre - post)	.23	.36	-.11	-.15	.17
Alcohol							
	175 ms						
		Angry faces (pre - post)	-.07	-.14	-.12	-.60**	-.12
		Happy faces (pre - post)	.15	.13	-.39	-.17	-.20
	600 ms						
		Angry faces (pre - post)	-.19	-.27	-.18	-.30	.18
		Happy faces (pre - post)	-.02	.01	.23	.26	-.07

Note. * $p < .05$, ** $p < .01$

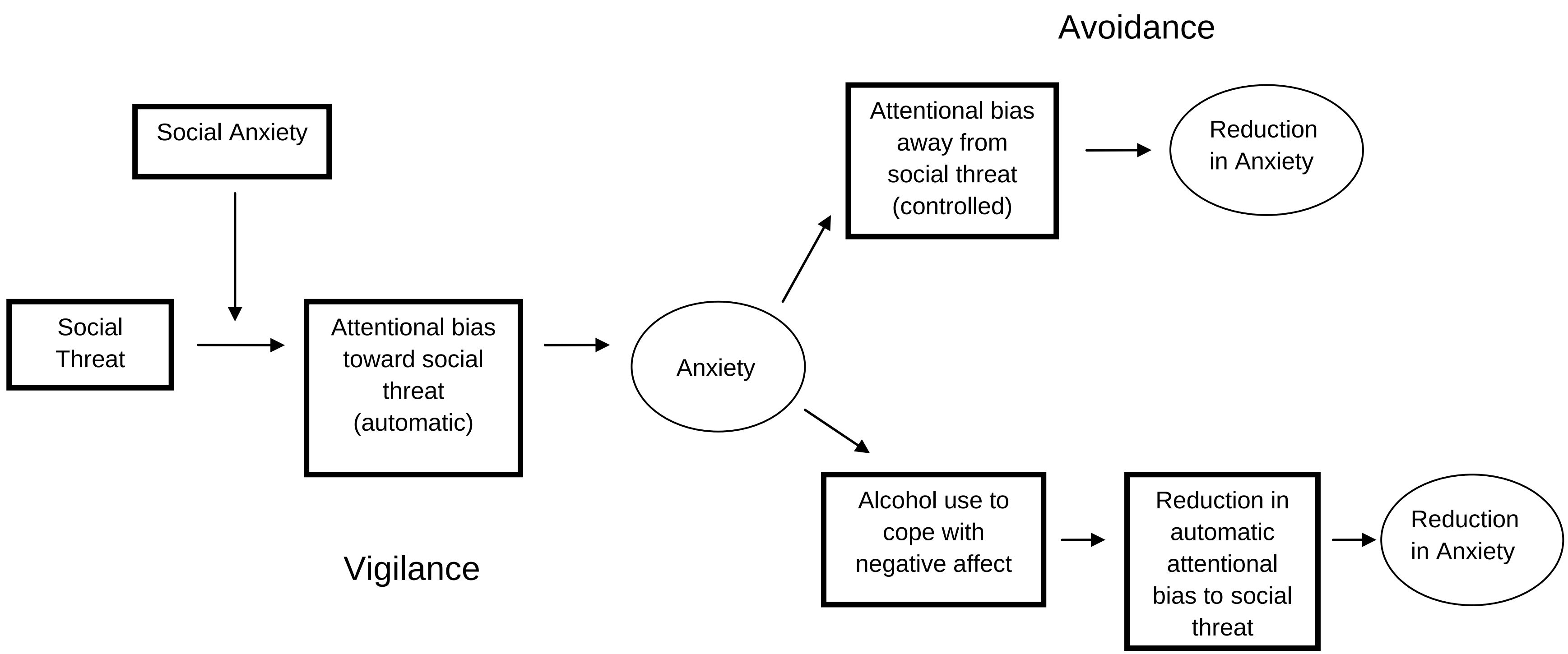

Figure 1. Avoidance-Coping Cognitive Model (Bacon & Ham, 2010)

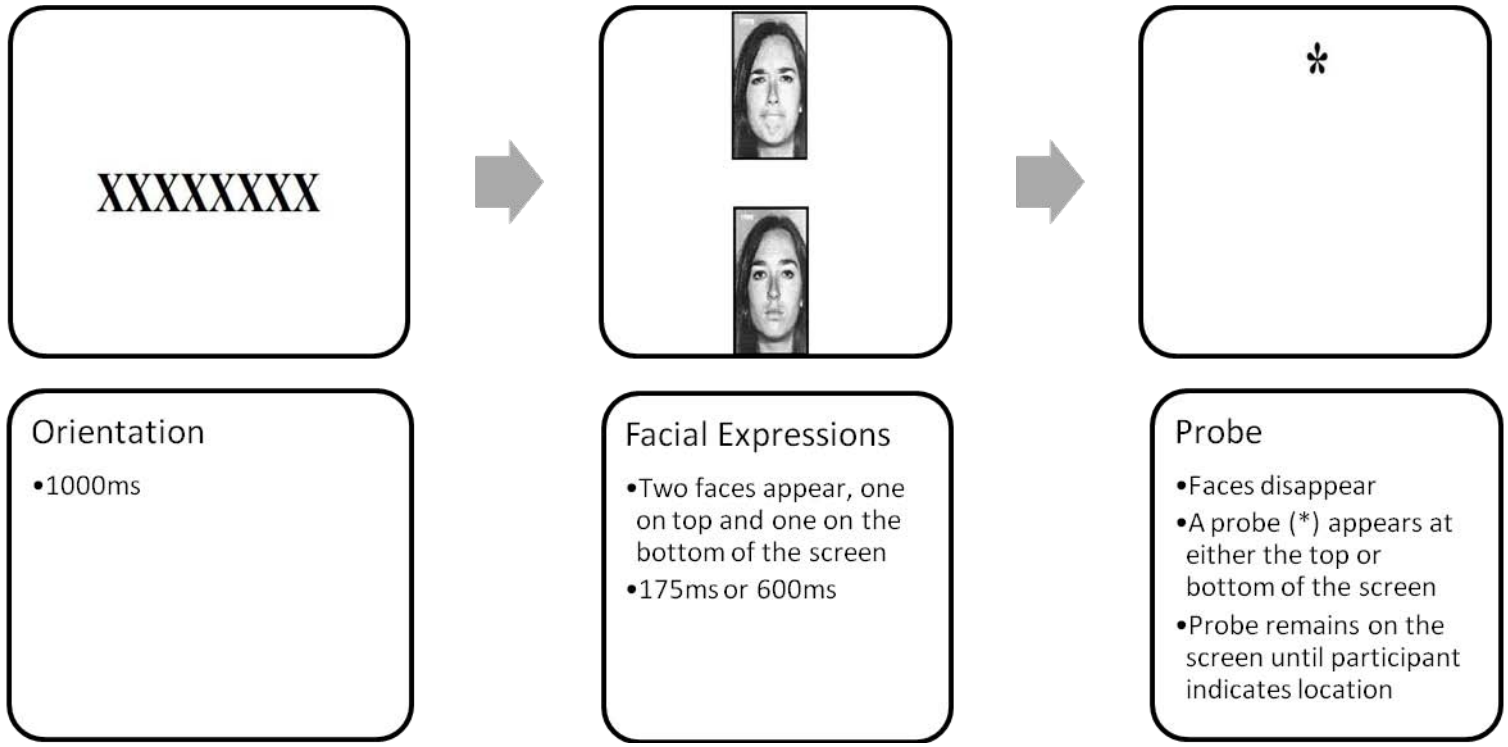

Figure 2. Illustration of the dot probe task

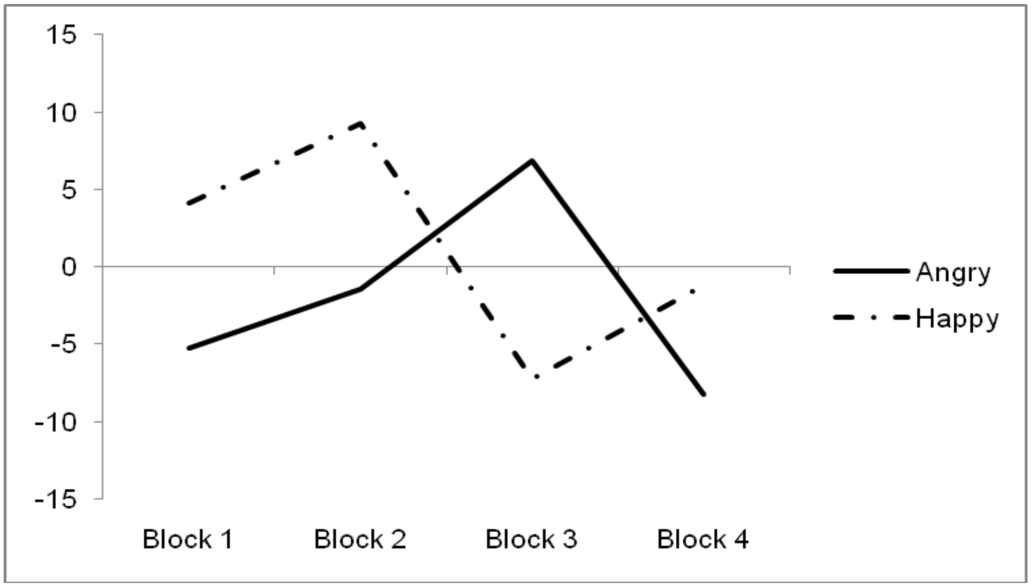

Figure 3. Bias scores by block at pre-beverage (collapsed by beverage condition) at 175ms

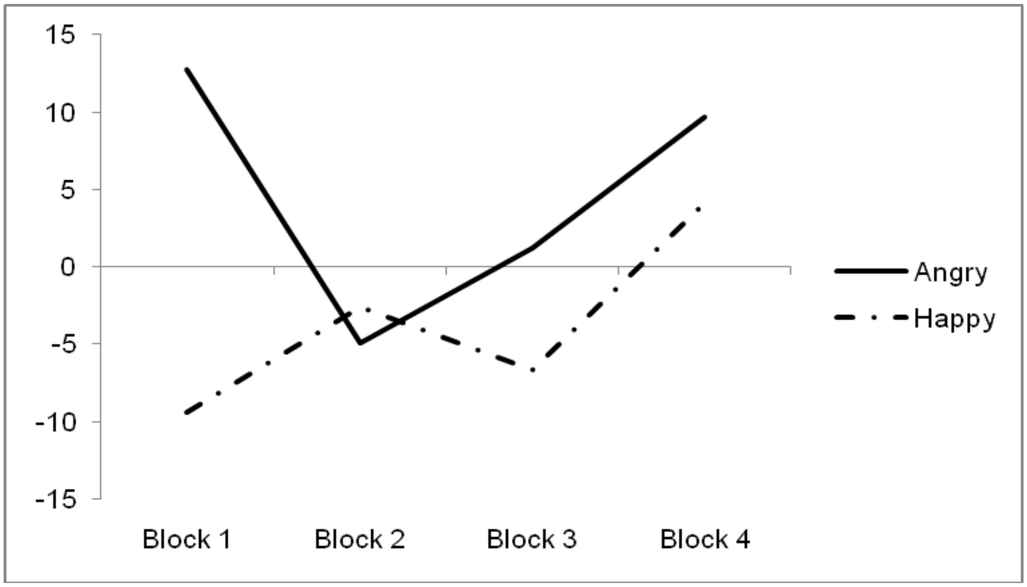

Figure 4. Bias scores by block at pre-beverage (collapsed by beverage condition) at 600ms

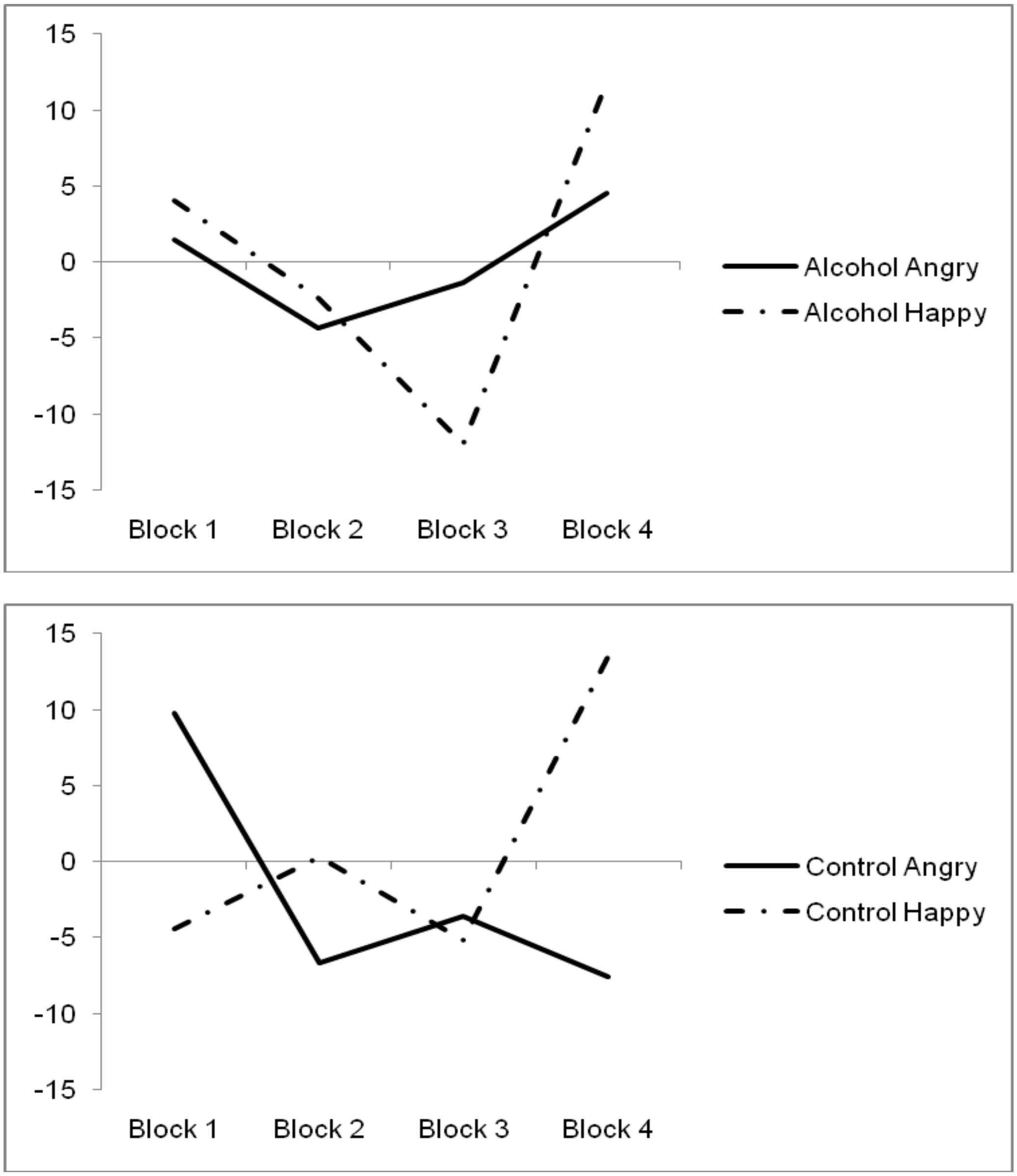

Figure 5. Bias scores by block post-beverage at 175ms. Top figure is for those in the alcohol condition, bottom figure for participants in the control condition.

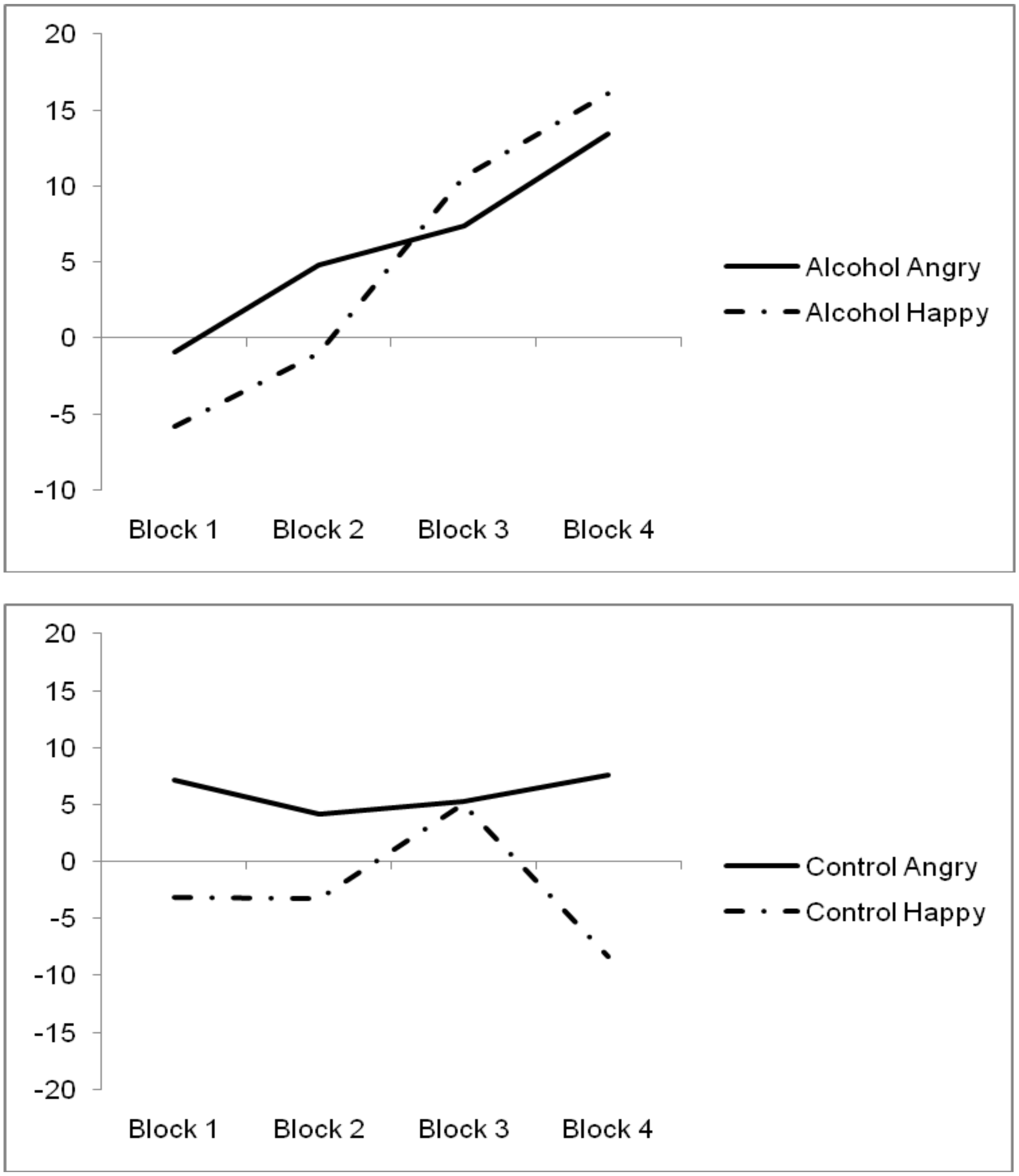

Figure 6. Bias scores by block post-beverage at 600ms. Top figure is for those in the alcohol condition, bottom figure for participants in the control condition.

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