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Comorbid interpretation and expectancy bias in social anxiety and alcohol use

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ABSTRACT

Background: In two studies, the present research examined whether being high in both social anxiety and alcohol use disorder symptoms is associated with a comorbid interpretation and expectancy bias that reflects their bidirectional relationship.
Design: Cross-sectional, quantitative surveys.
Methods: Measures of social anxiety and alcohol use disorder symptoms, as well as an interpretation and expectancy bias task assessing biases for social anxiety, drinking, and comorbid social anxiety and drinking.
Results: In Study 1 ($N = 447$), individuals high (vs. low) in social anxiety had stronger social threat bias and individuals high (vs. low) in alcohol use disorder symptoms had stronger drinking bias. Those high in both social anxiety and alcohol use disorder symptoms endorsed interpretations and expectancies linking social interaction with alcohol use. Comorbid bias predicted membership into the high social anxiety/drinking group, even after taking into account single-disorder biases. In Study 2 ($N = 325$), alcohol use disorder symptoms predicted drinking bias and social anxiety symptoms predicted social anxiety bias. Alcohol use disorder symptoms, social anxiety symptoms, and their interaction predicted comorbid interpretation and expectancy bias.
Conclusion: Results indicate unique cognitive vulnerability markers for persons with comorbid social anxiety and alcohol use disorder symptoms, which may improve detection and treatment of this serious comorbidity.

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Social anxiety; alcohol; comorbid; interpretation bias; expectancy bias

Introduction

Social anxiety and alcohol use disorders are highly debilitating and frequently co-occurring (e.g., Morris, Stewart, & Ham, 2005; Smith & Randall, 2012), with roughly half of individuals diagnosed with social anxiety disorder also qualifying for a diagnosis of an alcohol use disorder (e.g., Grant et al., 2005). Both social anxiety and alcohol use have underlying cognitive biases that maintain and worsen their respective symptoms, but they have largely been examined separately. For example, studies have found that those high (vs. low) in social anxiety are quicker to recognize visual cues that convey social threat (e.g., faces displaying anger; Mogg, Philippot, & Bradley, 2004), and assign more negative interpretations to ambiguous social contexts (e.g., Murphy, Hirsch, Mathews, Smith, & Clark, 2007). Similarly, those high (vs. low) in alcohol use are quicker to

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recognize stimuli pertaining to alcohol use (e.g., Field & Cox, 2008) and are more likely to generate interpretations of ambiguous contexts that are consistent with alcohol use (e.g., Woud, Fitzgerald, Wiers, Rinck, & Becker, 2012). However, very little is known about the nature of cognitive biases for those high in *both* social anxiety and alcohol use. Across two studies, the present research examined whether being high in both social anxiety and alcohol use is associated with a comorbid interpretation and expectancy bias that reflects their bidirectional relationship. Isolating cognitive biases that are associated with social anxiety, alcohol use, and their intersection, may advance understanding of risk factors for comorbidity, as well as how to conceptualize and better treat co-occurring social anxiety and alcohol use.

Social anxiety and alcohol use are mutually reinforcing. On the one hand, drinking is believed to reduce tension in social contexts (e.g., Gilles, Turk, & Fresco, 2006; Lewis & O'Neill, 2000), with the most replicable effects showing a link between social anxiety and drinking for coping and conformity motives. On the other hand, reliance on drinking to facilitate social interaction leads to physiological effects that increase anxiety symptoms, ultimately eroding self-confidence and impairing relationship quality (Stapinski et al., 2014). This bidirectional relationship leads to a self-perpetuating cycle that gradually worsens symptoms of both social anxiety and alcohol use. Research demonstrates that those with comorbid social anxiety and alcohol use disorders have greater severity of symptoms and life impairment, and studies indicate that comorbidity is associated with poorer response to treatment than either disorder in isolation, likely due to the reinforcing relationship between these disorders (e.g., Driessen et al., 2001; Schneier, Martin, Liebowitz, Gorman, & Fyer, 1989).

Research on cognitive biases differentiates among many forms of bias, including attentional bias, which focuses on the cues people selectively attend to in their environment, interpretation bias, which focuses on the meanings people assign to ambiguous situations, and expectancy bias, which focuses on selective predictions about how events will turn out. The current investigation draws insights from the attention bias literature to guide predictions about likely group differences in interpretation and expectancy bias. For example, research on attentional bias using the Stroop task has found that problem drinkers are faster to respond to alcohol-related (vs. control) words, whereas individuals high in social anxiety are faster to respond to socially threatening (vs. control) words (see discussion of variable results in Teachman, Joormann, Steinman, & Gotlib, 2012), and that a high level of drinking to cope with negative affect and problems is associated with biased processing for both types of words (Carrigan, Drobes, & Randall, 2004). The findings for persons who drink to cope also raise interesting connections to the drinking motives literature, particularly for negative reinforcement motives. Based on self-report scales, research on motives has generally found that those high (vs. low) in social anxiety have greater motivation to use alcohol as a way of enhancing positive mood and facilitating social acceptance, while the most consistent findings have been for using alcohol to cope with distress (e.g., Buckner, Eggleston, & Schmidt, 2006; Stewart, Morris, Mellings, & Komar, 2006). Our investigation of bias builds from these valuable prior literatures, but does not focus on selective attention (as in attention bias) or self-reported cognitive content (as in drinking motives); instead, the focus is on the process of assigning meanings and making predictions in ambiguous past and future situations, thereby providing a greater understanding of how people's pre-existing beliefs influence their responses under conditions of uncertainty.

There is a large literature establishing biases tied to social anxiety and the tendency to assign threatening meanings to ambiguous social contexts (e.g., Amir, Foa, & Coles, 1998; Amir, Beard, & Bower, 2005; Stopa & Clark, 2000). While there is far less empirical support for analogous biases tied to alcohol use, following the seminal study of Stacy (1997) finding that single-word interpretation bias (i.e., bias that is revealed from coding free associations to alcohol-related words such as draft and shot) is associated with prospective drug use, recent work using scenario-based methods is promising. For example, when asked to provide open-ended responses to ambiguous alcohol-related scenarios encountered in daily life (e.g., being at a festival and wanting to have fun with your friends), individuals high (vs. low) in alcohol use were more likely to produce alcohol-related continuations (Woud et al., 2012). Further, studies have found that coping motives are associated with the endorsement of

alcohol-related words in negative affect situations (Salemink & Wiers, 2014), which predicts prospective drinking (Woud, Becker, Rinck, & Salemink, 2015). There is also clear evidence for anxiety-linked expectancy biases, wherein highly anxious individuals disproportionately expect more negative or less positive, future outcomes (e.g., Cabeleira et al., 2014; Pabst, Kraus, Piontek, Mueller, & Demmel, 2014; Stacy, Widaman, & Marlatt, 1990; Steinman, Smyth, Bucks, MacLeod, & Teachman, 2013). Analogously, there is a rich literature on the role of positive alcohol expectancies (e.g., tied to the consequences of drinking) in promoting alcohol use (e.g., Pabst et al., 2014; Stacy et al., 1990).

It is theorized that, for those high in alcohol use disorder symptoms, being presented with a potentially alcohol-related context activates established associations in memory that lead to endorsement of alcohol-related interpretations and expectancies. For individuals high in both social anxiety and alcohol use disorder symptoms, frequent and intense experiences of alcohol use in relation to social contexts may be both a risk factor for, and a consequence of, memory associations that reflect this pairing. Thus, when presented with an ambiguous social context that may trigger fears of negative evaluation (e.g., going to the fridge after arriving at a friend's party), these individuals may be more likely to pick an alcohol-related explanation or make an alcohol-related prediction (e.g., because an alcoholic drink will help me interact with others), than would others with a high level of only social anxiety, only alcohol use, or neither problem.

To our knowledge, the present investigation is the first to examine specificity of interpretation and expectancy biases tied to social anxiety, alcohol use, and their co-occurrence. In Study 1, participants were screened online for inclusion into one of four factorial groups: (1) high social anxiety/high alcohol use; (2) low social anxiety/high alcohol use; (3) high social anxiety/low alcohol use; (4) low social anxiety/low alcohol use. All participants completed bias tasks for social anxiety, alcohol use, and comorbid social anxiety and alcohol use; the latter two are novel adaptations developed for this study of a previously established social anxiety interpretation bias measure. We expected the bias tasks to detect meaningful differences between individuals high and low in social anxiety and alcohol use disorder symptoms, providing evidence for known groups validity. Specifically, we expected those high (vs. low) in social anxiety to have a stronger social anxiety bias, and those high (vs. low) in alcohol use disorder symptoms to have a stronger alcohol bias, replicating prior work examining single-disorder biases. Further, we expected those high in *both* social anxiety and alcohol use disorder symptoms to have the strongest comorbid interpretation and expectancy bias, compared to all other groups. Moreover, we expected that the comorbid bias would add to the prediction of comorbid group membership even after controlling for the prediction offered by the single-disorder biases.

In Study 2, using data from college students in the Netherlands, we sought to replicate findings from Study 1. Because participants were not selected for high and low alcohol use disorder symptoms and social anxiety (i.e., no cut-points were used), we used dimensional scores of social anxiety and alcohol use disorder symptoms rather than artificially form discrete groups on measures that were not expected to be bimodal in this unselected sample. Similar to Study 1, we expected those higher (vs. lower) in social anxiety to have a stronger social anxiety bias, and those higher (vs. lower) in alcohol use disorder symptoms to have a stronger alcohol bias. Importantly, we expected the *interaction* of social anxiety and alcohol use disorder symptoms (i.e., comorbid symptom level) to predict comorbid interpretation and expectancy bias, even after taking into account single-disorder symptom levels.

Study 1

Method

Participants

In total, $N = 447$ Amazon Mechanical Turk (MTurk) participants consented and were paid to participate in an online study (59% female, $M_{age} = 35.8$, $SD = 11.8$). Importantly, research has shown that

MTurkers have prevalence of drug/alcohol use that either exceed or are on par with prevalence rates found in the general population, and that MTurkers tend to be honest in disclosing responses to sensitive measures (e.g., Rand, 2012; Shapiro, Chandler, & Mueller, 2013). Of this group, $n = 361$ completed sufficient measures to be included in the final analyses. The remaining $n = 86$ either dropped out of the study prematurely or did not complete the social anxiety and/or alcohol use symptom measures, which were necessary to confirm group assignment. Analyses revealed no significant differences in age ($t(446) = 1.66$, $p = .10$), gender ($\chi^2(1,446) = .31$, $p = .58$), or race ($\chi^2(1,416) = .03$, $p = .86$), between those who completed the study and those who did not. The majority of participants self-identified as White (83.9%), followed by 8.9% African American, 3.6% Asian American, 0.7% American Indian, and 2.9% self-identified as "other or unknown." All participants had IP addresses indicating that they lived in the U.S. at the time of the study.

Participants were screened for study inclusion using items that were modified from screening items on the Structured Clinical Interview for DSM-IV. A 2-item measure asked about intensity of anxiety experienced in social situations: "To what extent have you been especially nervous or anxious in social situations that involve people that you don't know very well?" and "To what extent have you been especially nervous or anxious doing things in front of other people, like speaking, eating, or writing?" Responses were provided on a 1–7 scale, from 1 = not at all to 7 = extremely. A score of 5–7 on either social anxiety screener item was selected to indicate high social anxiety, whereas a score of 1–4 indicated low social anxiety. Analogously, a 1-item measure asked about frequency of heavy drinking episodes: "Has there been a time in the past year when you had five or more drinks (for men) or four or more drinks (for women) on one occasion?" Responses were provided on a 1–7 scale to indicate frequency of heavy drinking episodes: 1 = 0 times; 2 = 1 or 2 times; 3 = 3–8 times; 4 = about once a month; 5 = about once a week; 6 = several days per week; 7 = almost every day. A score of 5–7 on the alcohol screener was selected to indicate high alcohol use (i.e., at least weekly heavy drinking episodes), whereas a score of 1–4 indicated low alcohol use. Based on this preliminary screen for the $N = 447$ consenting sample, participants were allocated as follows: (1) high alcohol use/high social anxiety (referred to as Hi AU/Hi SA; $n = 100$); (2) high alcohol use/low social anxiety (Hi AU/Lo SA; $n = 102$); (3) low alcohol use/high social anxiety (Lo AU/Hi SA; $n = 125$); and (4) low alcohol use/low social anxiety (Lo AU/Lo SA; $n = 120$). A high symptom, rather than diagnosed, sample was used in part to facilitate recruitment of a large sample, and in part to follow National Institute of Mental Health recommendations for a Research Domain Criteria approach that examines these problem areas on a continuum (Cuthbert, 2015; Vaidyanathan, Vrieze, & Iacono, 2015).

Consistent with recommendations for studies using MTurk samples (e.g., Chandler, Mueller, & Paolacci, 2014; Shapiro et al., 2013), we sought to enforce a rigorous standard for group membership. Thus, in addition to the preliminary screening questions, we used moderate (and severe, for secondary analyses) cutoff scores based on the Social Interaction Anxiety Scale (SIAS; Mattick & Clarke, 1998) and the Alcohol Use Disorders Identification Test (AUDIT; Saunders, Aasland, Babor, De la Fuente, & Grant, 1993), to help ensure that only those actually high or low in social anxiety and alcohol use disorder symptoms were retained in our analyses. Based on previous recommendations (Brown et al., 1997; Heimberg, Mueller, Holt, Hope, & Liebowitz, 1992; Mattick & Clarke, 1998), a score of 34 (out of a possible 80) was used as a cutoff for moderate social anxiety, whereas a minimum score of 43 was used as a severe cutoff. In line with past research (e.g., Babor, Higgins-Biddle, Saunders, & Monteiro, 2001; Conigrave, Hall, & Saunders, 1995), a score of 8 (out of a possible 40) was used as a cutoff for moderate alcohol use disorder symptoms, whereas a minimum score of 11 was used as a severe cutoff. When applying moderate cutoffs, sample sizes for the Hi AU/Hi SA, Hi AU/Lo SA, Lo AU/Hi SA, and Lo AU/Lo SA groups were $n = 53$, 63, 59, and 62, respectively (total $N = 237$; 58% female, $M_{age} = 35.4$, $SD = 11.9$). When applying severe cutoffs, sample sizes were $n = 32$, 43, 41, and 62, respectively (total $N = 178$; 55% female, $M_{age} = 35.8$, $SD = 12.4$). Notably, the pattern of results was very similar whether applying no, moderate, or severe cutoffs. However, to bolster confidence that findings

reflect high symptom samples, we report the analyses here using cutoffs (details on analyses with no cutoffs are available from the first author).

Measures and tasks[1]

Social Anxiety. The SIAS (Mattick & Clarke, 1998) assesses distress from social interactions. Participants rated the degree to which they agreed with 20 statements (e.g., *I have difficulty talking with other people)* from 0 = not at all characteristic of me to 4 = extremely characteristic of me. The SIAS has been found to have good discriminant validity in differentiating individuals with social anxiety disorder from healthy control groups (e.g., Heimberg et al., 1992). Internal consistency (Cronbach's alpha) in the current sample was excellent ($\alpha = .96$).

Alcohol Use Disorder Symptoms. The AUDIT assesses risk for alcohol use disorder symptoms. Participants respond to 10 questions about their drinking behavior and consequences of drinking (e.g., *Have you or someone else been injured as a result of your drinking?*) on a 0–4 likert scale, with higher scores indicating more alcohol use disorder symptoms. The AUDIT is one of the most popular measures used in detecting alcohol use disorders and is widely used in clinical settings (e.g., Bohn, Babor, & Kranzler, 1995; Daeppen, Yersin, Landry, Pécoud, & Decrey, 2000). Internal consistency was very good ($\alpha = .90$).

Interpretation and Expectancy Bias. All participants completed bias tasks for social anxiety, alcohol use, and comorbid social anxiety and alcohol use. The order of tasks was randomized for each participant. In each task, participants were presented with a set of eight ambiguous scenarios, each followed by three possible explanations for the situation. Participants were asked to rate (0 = not at all likely; 8 = extremely) the degree to which each of the three explanations would likely be true if they were in that situation. Among the three response options provided, one was always disorder/comorbidity-relevant. For each type of bias (social anxiety, alcohol, and comorbid social anxiety and alcohol use), we calculated the average item score for the negative, disorder/comorbidity-relevant response option across the set of scenarios for that bias type. Scenarios for the social anxiety task (e.g., *You notice a frowning stranger approaching you in the street. Why?*) were taken from the Brief Body Sensations Interpretations Questionnaire (BBSIQ; Clark et al., 1997). One of the explanations for each scenario is negative (e.g., *You have done something wrong and are about to be told*), whereas the other responses are either neutral or positive (e.g., *He's lost and wants directions*; *You dropped something and he's returning it*). Endorsement of negative explanations is used to indicate assignment of socially threatening meanings. Consistent with expectations, internal consistency for negative explanations ($\alpha = .90$) was good.

The alcohol, as well as the comorbid social anxiety and alcohol, bias tasks were developed for this study by modifying the content of the BBSIQ, but following the same format (see Appendix). Scenarios for the alcohol task (e.g., *After being stuck in traffic on your drive home, you eagerly head to your fridge. Why?*) were motivated by non-social events from the Rutgers Alcohol Problem Index (RAPI; White & Labouvie, 2000). One of the explanations for each scenario is always associated with alcohol (e.g., *You deserve a glass of wine to unwind*), whereas the other responses are not (e.g., *You need to start getting dinner organized because you're hungry*; *You've been thinking about the leftover dessert from the night before*). Modeling scoring for the BBSIQ and to focus on disorder-specific interpretations and expectations, only endorsements of alcohol-related explanations were used in analyses. Internal consistency for alcohol-related explanations ($\alpha = .88$) ($\alpha = .84$) was good.

The comorbid task included interpersonal scenarios involving: drinking to manage a social situation (e.g., *You arrive at a friend's birthday party and immediately go to the fridge to see what's there. Why?*), drinking to reduce shame after a social situation (e.g., *You just had to give a big presentation at work, and now want to get back to your office and shut the door. Why?*), and embarrassment after a heavy drinking episode (e.g., *You don't want to go into work today and try to think of a good excuse to stay home. Why?*). One of the explanations for each scenario (the one that is used for scoring) is always associated with a link between social concerns and alcohol use (e.g., *You got drunk at the office party last night and are afraid you made a fool of*

yourself), whereas the other responses are not (e.g., *You are behind on a project and know your boss will be mad at you*; *It's the first day of good weather in weeks, and you want to be outside*). Consistent with expectations, internal consistency for social concern/alcohol explanations ($\alpha = .91$) was good.

Procedure

Participants were told the study examined how people think about social interactions and alcohol use. Before participating in the study, participants completed the preliminary screening items for social anxiety and alcohol use. After providing consent and demographic information, participants completed three domain-specific blocks (i.e., social anxiety, alcohol use and comorbid social anxiety and alcohol use). Each single disorder block included the associated bias task and symptom questionnaire (i.e., SIAS for social anxiety, AUDIT for alcohol use). The comorbid social anxiety and alcohol use block included the bias task and also the Modified Drinking Motives Questionnaire (Grant, Stewart, O'Connor, Blackwell, & Conrod, 2007; which is not included in these analyses given it was not central to the current study's primary questions). Within each block, the bias task was always presented before the questionnaire. The order of social anxiety, alcohol use, and comorbid blocks was randomized across participants. Participants were directed to a debriefing page after completing all three blocks. This study was approved by the University of Virginia Institutional Review Board.

Plan for analysis

We performed two different sets of analyses. The first set predicted bias scores from group membership (Group → Bias). We computed one-way analyses of covariance (ANCOVAs), controlling for age and gender. Tukey's method for multiple comparisons was used to examine group contrasts in bias scores which accounts for multiple comparisons (McHugh, 2011). The second set predicted group membership from bias (Bias → Group). We conducted a multinomial logistic regression analysis. Multinomial logistic regression is a classification method used to predict probabilities of different categorical outcomes (Cramer & Ridder, 1991; Peng & Nichols, 2003). We predicted group membership using dimensional bias scores. In a single regression model, all three bias scores (alcohol, social anxiety, comorbid) were entered as simultaneous predictors. Though the dependent variable was composed of four categorical levels (corresponding to the four groups), the output displays pairwise comparisons between a referent group and every other group. The odds ratio (OR) reflects whether a one unit change in a predictor variable will change the odds of being classified in the referent group relative to another group. Specifically, an OR greater than 1.0 suggests that a one unit change in bias score is likely to increase the probability of inclusion in the referent group, whereas an OR less than 1.0 suggests that a one unit change in bias score is likely to increase the probability of inclusion in the contrast group. Thus, a significant OR suggests that an increase in bias is more strongly predictive of inclusion in the referent group than the contrast group. Because the primary focus of the current study was to examine whether comorbid social anxiety and alcohol use disorder symptoms was associated with a comorbid interpretation and expectancy bias, the referent group in each case was group 1 (high alcohol use disorder symptoms and high social anxiety; Hi AU/Hi SA). Together, these analyses provided a robust test of our hypotheses by examining whether bias scores differed by group, and whether bias scores predict group membership.

For all analyses below, we report findings using moderate cut points for AUDIT and SIAS to maximize data inclusion. The pattern of findings was very similar regardless of whether moderate or severe cut points were used, and we note throughout when the pattern of findings differed. Given the multiple tests involved, we chose a more stringent alpha of $p = .01$ to determine significance for our main outcomes.[2]

Results

Data preparation and descriptive statistics

There were no significant group differences in age, race, or ethnicity, using moderate or severe cutoffs to form the groups. As expected, one-way ANOVAs revealed significant group differences in social anxiety (SIAS: $F(3,233) = 231.058$, $\eta^2 = .748$, $p < .001$) and alcohol use (AUDIT: $F(3,233) = 123.374$, $\eta^2 = .614$, $p < .001$; see Table 1). There were also significant group differences in gender composition ($F(3,233) = 5.277$, $\eta^2 = .064$, $p = .002$) such that the Hi AU/Hi SA and Lo AU/Hi SA groups were composed of more women than were the Hi AU/Lo SA and Lo AU/Lo SA groups. Importantly, there were no Group × Gender interactions for any bias scores, using either the moderate or severe cutoffs. Descriptive statistics for bias and symptom scores for each group can be seen in Table 1.

Group differences in bias

One-way ANCOVAs revealed significant group differences for all bias scores, even after controlling for age and gender (for Alcohol, $F(3, 225) = 23.510$, $\eta^2 = .349$, $p < .001$; for Social Anxiety, $F(3, 233) = 5.715$, $\eta^2 = .112$, $p < .001$; for Comorbid, $F(3, 217) = 16.732$, $\eta^2 = .284$, $p < .001$).

Alcohol. As seen in Figure 1 (top right), as expected, groups with alcohol use disorder symptoms had stronger alcohol biases than did groups low in alcohol use disorder symptoms. Specifically, the Hi AU/Hi SA and Hi AU/Lo SA groups had significantly stronger alcohol biases than did the Lo AU/Hi SA ($B = 2.61$, $t = 10.53$, $p < .001$, and $B = 2.04$, $t = 8.65$, $p < .001$, respectively) and Lo AU/Lo SA ($B = 2.79$, $t = 11.29$, $p < .001$, and $B = 2.24$, $t = 9.69$, $p < .001$, respectively) groups. There was no significant difference between the Hi AU/Hi SA and Hi AU/Lo SA groups in alcohol bias.

Social anxiety. As seen in Figure 1 (top left), groups with high social anxiety had stronger social anxiety biases than did groups low in social anxiety. Specifically, the Hi AU/Hi SA group had significantly stronger bias scores than did the Hi AU/Lo SA ($B = 1.67$, $t = 6.212$, $p < .001$) and Lo AU/Lo SA ($B = 2.04$, $t = 7.37$, $p < .001$) groups, but not the Lo AU/HI SA ($B = .78$, $t = 2.80$, $p = .028$) group. Further, the Lo AU/Hi SA group had stronger social anxiety bias scores than did the Lo AU/Lo SA group ($B = 1.27$, $t = 4.78$, $p < .001$) and the Hi AU/Lo SA group ($B = .89$, $t = 3.36$ $p = .005$).

Comorbid. As expected, there was a pattern for comorbid bias such that the Hi AU/Hi SA group had stronger comorbid bias compared to *all* other groups. Specifically, the Hi AU/Hi SA group had stronger bias scores than did the Hi AU/Lo SA ($B = 1.76$, $t = 7.58$, $p < .001$), Lo AU/Hi SA ($B = 2.38$, $t = 9.93$, $p < .001$), and Lo AU/Lo SA ($B = 2.89$, $t = 12.03$, $p = <.001$) groups. The Hi AU/Lo SA group had a stronger comorbid bias score than did the Lo AU/Hi SA ($B = .62$, $t = 2.71$, $p = .036$) group, although this did not reach significance. The Hi AU/Lo SA group had a significantly stronger comorbid bias scores than did the Lo AU/Lo SA ($B = 1.13$, $t = 5.05$, $p < .001$) group.

Table 1. Descriptive statistics (mean, standard deviation) for social anxiety, alcohol use, and interpretation bias scores by symptom group.

			Interpretation Bias		
Study 1 Group	SIAS	AUDIT	Alcohol	Social Anxiety	Comorbid
Hi AU/Hi SA	49.74	17.64	3.99	4.03	4.74 (1.51)
(high alcohol, high social anxiety; $n = 53$)	(9.84)	(6.09)	(1.57)	(1.59)	
Hi AU/Lo SA	17.10	14.79	3.44	2.31	2.96 (1.21)
(high alcohol, low social anxiety; $n = 63$)	(8.92)	(6.03)	(1.52)	(1.36)	
Lo AU/Hi SA	50.51	3.49	1.27	3.21	2.33 (1.21)
(low alcohol, high social anxiety; $n = 59$)	(10.87)	(2.30)	(.96)	(1.28)	
Lo AU/Lo SA	16.29	3.63	1.26	1.88	1.83 (.95)
(low alcohol, low social anxiety; $n = 62$)	(9.41)	(2.19)	(1.26)	(1.44)	
Study 2 Full sample	23.22	10.53	1.58	2.66	1.38 (1.01)
	(13.81)	(5.62)	(1.22)	(1.16)	

Note. SIAS = Social Interaction Anxiety Scale; AUDIT = Alcohol Use Disorders Identification Test; AU = alcohol use; SA = social anxiety. Interpretation bias scores reflect raw means (and standard deviations) using moderate cutoffs for AUDIT (low = <8, moderate = 8 or above) and SIAS (low = <34, moderate = 34 or above).

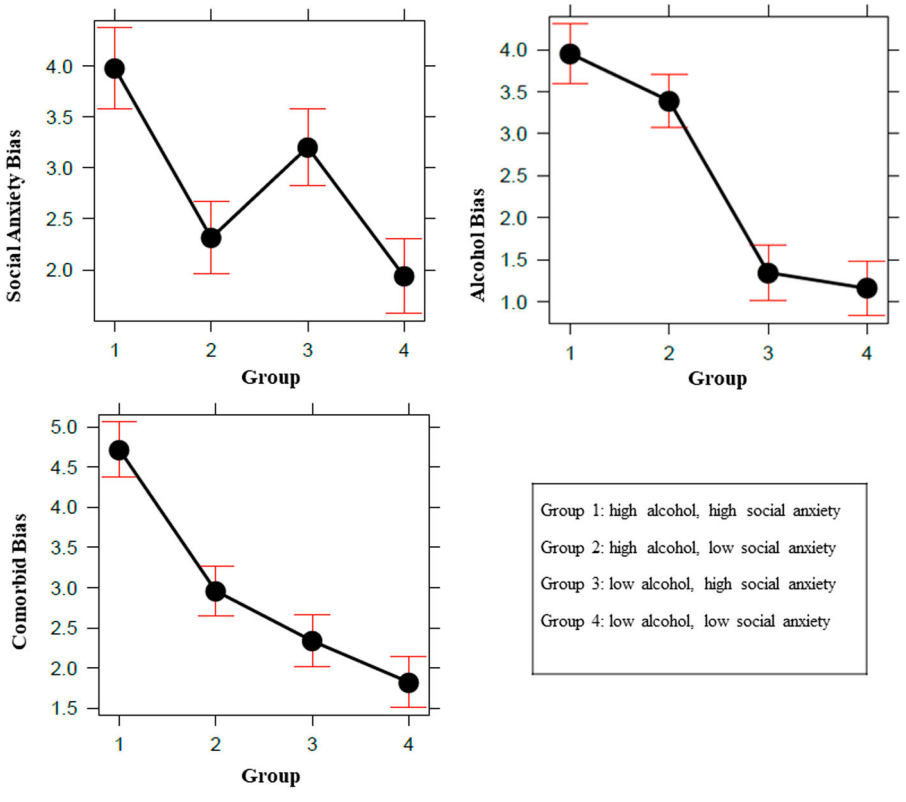

Figure 1. Study 1 Bias scores for each group.

Taken together, these results indicate that being high in alcohol use disorder symptoms is associated with an alcohol bias, regardless of social anxiety level, while being high in social anxiety is associated with a social anxiety bias, regardless of alcohol use disorder symptom level, consistent with previous work showing single-disorder biases. Most importantly, those high in both alcohol use disorder symptoms *and* social anxiety had a significantly stronger comorbid interpretation and expectancy bias than did all other groups.

Bias predicting group membership

The multinomial logistic regression indicated the full model provided significantly better prediction than the null model, $\chi_2(9) = 130.40$, $p < .001$; see Table 2. As expected, higher alcohol bias scores significantly predicted membership into the Hi AU/Hi SA group versus the Lo AU/Hi SA and Lo AU/Lo SA groups. Higher social anxiety bias scores was associated with membership into the Hi AU/Hi SA group versus the Hi AU/Lo SA group, but this effect did not reach significance. Unexpectedly, higher social anxiety bias scores did not significantly predict membership into the Hi AU/Hi SA group versus the Lo AU/Lo SA group. Importantly, higher comorbid bias scores significantly predicted membership into the Hi AU/Hi SA group versus the Hi AU/Lo SA and Lo AU/Lo SA groups, as well as versus the Lo AU/Hi SA group although this did not reach significance. Overall, these findings mirrored those found for group contrasts, indicating that higher alcohol bias scores predicted membership into groups high in alcohol use disorder symptoms, and higher social anxiety bias scores predicted membership into groups high in social anxiety. Critically, higher comorbid bias scores predicted membership into the group composed of high alcohol use disorder symptoms *and* high social anxiety versus all other groups, even after controlling for the single disorder biases.

Table 2. Study 1 Multinomial logistic regressions using interpretation bias scores to predict group membership.

	Hi AU/Lo SA	Lo AU/Hi SA	Lo AU/Lo SA
Interpretation Bias			
Alcohol	1.65	.25	.47
	(1.10, 2.48)	(.15, .44)	(.28, .81)
	$p = .016$	$p < .001$	$p = .007$
Social Anxiety	.68	1.44	.73
	(.49, .95)	(.97, 2.14)	(.49, 1.09)
	$p = .024$	$p = .069$	$p = .126$
Comorbid	.33	.52	.30
	(.20, .56)	(.31, .86)	(.16, .56)
	$p < .001$	$p = .012$	$p < .001$

Note. AU = alcohol use, SA = social anxiety. Scores reflect odd-ratios (and 95% confidence intervals) from multinomial logistic regression. In all cases, referent group = Hi AU/Hi SA. Odds ratios less than 1.00 indicate that an interpretation bias score is more strongly predictive of inclusion in the Hi AU/Hi SA group than the contrast group, whereas odds ratios greater than 1.00 indicate that an interpretation bias score is less strongly predictive of inclusion in the Hi AU/Hi SA group than the contrast group.

Study 2

Method

Participants

Participants were 325 first year psychology students at the University of Amsterdam, the Netherlands (67% female, $M_{age} = 19.8$, SD = 2.0). These students participated in the so-called "test-week", which is held every year for freshmen psychology students at this university. During this "test-week", a wide variety of psychological assessments are administered, including the measures for the current study. All participants provided written informed consent, and the study was approved by the Ethical Committee of the Faculty of Social and Behavioral Sciences, University of Amsterdam. Participants received course credit as compensation.

Measures and tasks

Social Anxiety. A Dutch version of the SIAS (Mattick & Clarke, 1998) assessed distress from social interactions. As in the English version, participants rated the degree to which they agreed with 20 statements (e.g., *I have difficulty talking with other people)* from 0 = not at all characteristic of me to 4 = extremely characteristic of me ($M = 23.1$, $SD = 13.8$). Internal consistency in the current sample was excellent ($\alpha = .92$).

Alcohol Use Disorder Symptoms. A Dutch version of the AUDIT (Saunders et al., 1993) assessed risk for alcohol use disorder symptoms. Participants responded to 10 questions about their drinking behavior and consequences of drinking (e.g., *Have you or someone else been injured as a result of your drinking?*) on a 0–4 likert scale, with higher scores indicating more alcohol use disorder symptoms ($M = 10.6$, $SD = 5.6$). Internal consistency was adequate in the current sample ($\alpha = .73$).

Interpretation and Expectancy Bias. Participants completed the identical bias tasks for social anxiety, alcohol, and comorbid social anxiety and alcohol use as in Study 1, translated for a Dutch-speaking sample and modified slightly to be more appropriate for a student sample (i.e., fewer references to work-related situations). Similar to Study 1, the order of tasks was randomized for each participant. In the current sample, internal consistencies were adequate for negative explanations ($\alpha = .77$) in the social anxiety bias task, alcohol-related explanations ($\alpha = .77$) in the alcohol bias task, and social concern/alcohol explanations ($\alpha = .74$) in the comorbid bias task.

Procedure

Participants were told the study examined how people think about social interactions and alcohol use. After providing consent, participants completed three domain-specific blocks (i.e., social anxiety, alcohol use and comorbid social anxiety and alcohol use) composed of a bias task and

questionnaire (i.e., SIAS or AUDIT). Within each block, the bias task was always presented before the questionnaire to reduce the likelihood that priming of symptoms on the questionnaire would influence interpretation or expectancies on the bias task. The order of social anxiety, alcohol use, and comorbid blocks was randomized across participants.

Plan for analysis

We performed three sets of linear regression analyses to predict bias scores from alcohol use disorder symptoms, social anxiety, and comorbid symptoms. Comorbid symptoms were computed by multiplying AUDIT and SIAS scores, and is represented by the interaction term. In each regression model, z-scores for the mean-centered AUDIT and SIAS were entered simultaneously in the first step, and then their standardized interaction term was entered in the second step. Standardized bias scores (alcohol, social anxiety, or comorbid) served as the dependent variable in each model. To account for performing separate statistical tests, we used a conservative Bonferroni correction of .05/3 that produces an alpha of .017.

Results

Overall, results largely replicated those in Study 1. Specifically, a greater severity of alcohol use disorder symptoms significantly predicted a stronger alcohol bias ($B = .56$, $t = 12.13$, $p < .001$), while severity of social anxiety ($B = -.07$, $t = -1.51$, $p = .13$) and comorbid ($B = .004$, $t = .82$, $p = .94$, $\Delta r^2 < .001$) symptoms did not. Further, a greater severity of social anxiety ($B = .52$, $t = 11.08$, $p < .001$) and alcohol use disorder ($B = .11$, $t = 2.25$, $p = .03$) symptoms was associated with a stronger social anxiety bias, although this did not reach significance. A greater severity of comorbid symptoms was not significantly associated with a stronger social anxiety bias ($B = .06$, $t = 1.27$, $p = .21$). A greater severity of alcohol use disorder symptoms ($B = .11$, $t = 2.25$, $p = .03$, $\Delta r^2 = .003$) was associated with a stronger social anxiety bias, although this did not reach significance. Comorbid bias was significantly predicted by a greater severity of comorbid symptoms ($B = .11$, $t = 2.49$, $p = .013$, $\Delta r^2 = .012$), as well as social anxiety ($B = .37$, $t = 8.33$, $p < .001$) and alcohol use disorder ($B = .47$, $t = 10.49$, $p < .001$) symptoms. Follow-up simple slopes analysis revealed that the relationship between comorbid bias and alcohol use disorder symptoms was significant at 1 standard deviation above ($B = .59$, $t = 9.32$, $p < .001$) and below ($B = .35$, $t = 5.30$, $p < .001$) the mean on social anxiety symptoms. As seen in Figure 2, the effect of alcohol use disorder symptoms on comorbidity bias was particularly strong among those high (vs low) in social anxiety.[3] These findings indicate that comorbid alcohol use and social anxiety bias is strongly associated with the combination of a high level of *both* alcohol use disorder and social anxiety symptoms.

General discussion

Across two very different samples, we found convergent evidence that comorbid alcohol use and social anxiety symptoms are strongly associated with comorbid interpretation and expectancy bias. In Study 1, as predicted, individuals high (vs. low) in social anxiety symptoms had stronger social threat bias and individuals high (vs. low) in alcohol use disorder symptoms had stronger drinking bias. Note, those high in both social anxiety and alcohol use disorder symptoms had stronger social threat bias than did those high in social anxiety symptoms yet low in alcohol use disorder symptoms. This could be due to the reinforcing relationship between coping with social anxiety and alcohol misuse. Further, those high in both social anxiety and alcohol use disorder symptoms had the strongest tendency to endorse interpretations and expectancies that link social interaction with alcohol use. Comorbid bias predicted membership into the high social anxiety/drinking group, even after taking into account single-disorder biases. Findings from Study 1 support the known groups validity of the bias measures by demonstrating their ability to distinguish between those high versus low in social anxiety and alcohol use disorder symptoms. In Study 2, alcohol use

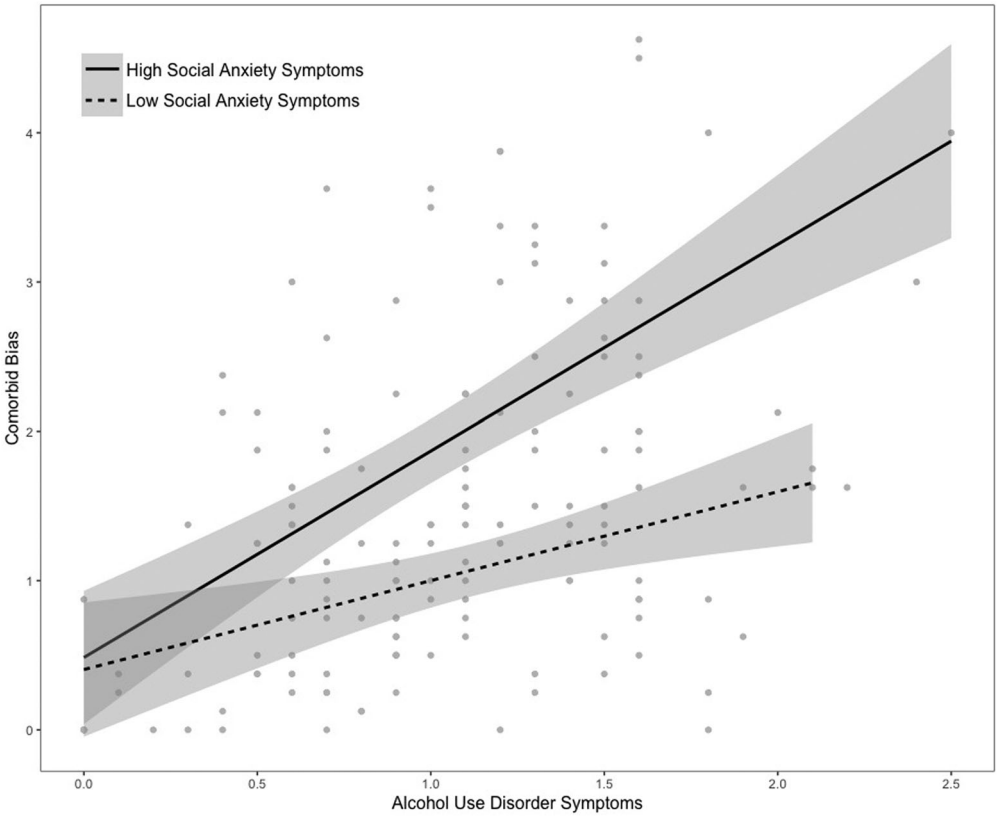

Figure 2. Effects of social anxiety and alcohol use disorder symptom levels on comorbidity bias.
Note. Low and High Social Anxiety Symptoms reflect the upper and lower thirds from the Dutch version of the Social Interaction Anxiety Scale.

disorder symptoms predicted drinking bias and social anxiety symptoms predicted social anxiety bias. Alcohol use disorder symptoms, social anxiety symptoms, and their interaction again predicted comorbid interpretation and expectancy bias.

Findings from Studies 1 and 2 provide reliable evidence across two very different samples that those with co-occurring social anxiety and alcohol use disorder symptoms possess comorbid biases that are not simply accounted by either single-disorder bias.

Though it is well known that social anxiety and alcohol use are mutually reinforcing, little research has examined how underlying cognitive factors may be involved in the etiology or maintenance of comorbid symptomology. The repeated pairing of alcohol use in relation to potentially threatening social contexts may, over time, initiate or strengthen comorbid biases that reflect this bidirectional relationship, which in turn may reinforce problematic alcohol and interpersonal behaviors (e.g., making drinking accessible as a response to manage social anxiety). While the current correlational data clearly cannot speak to questions of causality or temporal precedence, it seems likely that comorbid social anxiety and alcohol use symptomology may be both a cause and a consequence of comorbid biases, and future research may want to investigate these temporal and causal questions more closely. For example, use of repeated assessments in passive longitudinal studies may allow researchers to evaluate whether change in severity of comorbid social anxiety and alcohol use disorder symptoms predicts, and/or is predicted by, changes in comorbid biases. Similarly, development of cognitive bias modification approaches that reduce comorbid biases may reduce social anxiety and alcohol use disorder symptoms (e.g., Salemink, Woud, Roos, Wiers, & Lindgren, 2019). We expect that development of cognitive bias modification approaches that specifically target comorbid

biases may reduce social anxiety and alcohol use symptoms. For example, it may be possible to present individuals high in social anxiety and alcohol use disorder symptoms with an adapted version of the ambiguous scenarios used in our comorbid bias measure that systematically pairs socially anxious feelings with a non-alcohol way of coping / non-alcohol solution, to gradually attenuate the strength of association between alcohol misuse and social threat.

Along these lines, the current research has implications for treating comorbid social anxiety and alcohol use disorders, an important goal given comorbid individuals have poorer response to treatment than either disorder in isolation (e.g., Driessen et al., 2001; Schneier et al., 1989). One reason for this poorer response may be that treatments targeting *either* social anxiety or alcohol use disorder are typically only addressing single-disorder biases, thereby not accounting for the functional relationship between these disorders. This suggests clinicians may optimize treatment effectiveness by decreasing the belief that alcohol is a viable way to reduce *social* stress, while also increasing social skills to facilitate interactions in the absence of alcohol.

There are several suggestions for future research in light of limitations of the present study. Because data were collected from undiagnosed samples of MTurk and college student participants, future research is needed to replicate our findings of comorbid cognitive biases in a clinical sample and to evaluate whether the bias shows treatment sensitivity. Additionally, the cross-sectional nature of the data precludes us from making causal inferences. As noted, future research using experimental designs can help answer questions such as whether the bias causally contributes to comorbid risk or whether it is simply an artifact of long-term experience. It is also important to recognize that our measure was likely capturing multiple biases. We focused on interpretation and expectancy biases in our discussion given the scenarios asked about explaining past events and predicting future responses, but the field has long recognized that few measures are "process-pure" (see Sherman, 2008). The current interpretive and expectancy task is almost certainly influenced by other related biases, such as likelihood judgments and even perhaps memory biases, given close links between the different forms of bias. Further, based on prior literature (e.g., Sherman, 2008), it is likely that responses were influenced by both automatic (e.g., unintentional) and strategic (e.g., more consciously controlled) processes. Thus, it is difficult, if not impossible, to determine how much our findings were influenced by each of these distinct, yet highly overlapping, forms of bias. This concern is certainly not unique to our measure, and highlights the challenge -but importance- of isolating different types of bias to more precisely target interventions. Interestingly, the question of what different processes are captured by the task is theoretically distinct from our primary question of whether the task can effectively distinguish different disorder content domains (i.e., social anxiety, alcohol use, and comorbid social anxiety and alcohol use). However, we expect that process and content may not be totally independent in this case given the comorbidity content is thought to reflect a functional link between the social anxiety and alcohol use content domains, which presumably evolves through a variety of biased processes. Given the importance of isolating different types of bias for targeted interventions, we further encourage future studies to develop process-pure content measures of interpretive and expectancy biases. For example, such measures might be able to detect a specificity in bias that is only associated with comorbid symptom presentations, which could aid in screening for comorbidity. Finally, the study was limited to self-report measures, so future research may examine whether and for whom comorbid biases predict actual drinking in social situations. A strong association between comorbid biases and actual behavior would further highlight the importance of targeting comorbid cognitive biases in treatment.

A strength of the current study is the cross-cultural consistency of the results. Across samples, in the United States and Netherlands respectively, we found convergent evidence that comorbid alcohol use and social anxiety symptoms are strongly associated with comorbid interpretation and expectancy bias. If those high in both social anxiety and alcohol use disorder symptoms are characterized by a comorbid bias that is not solely accounted by single-disorder biases, it could help explain why traditional treatments targeting social anxiety and/or alcohol use as independent disorders are less than optimally effective. It will be exciting for future research to determine the clinical

significance and malleability of this bias to help the many people suffering with debilitating comorbid symptoms.

Notes

1. The materials reported here are part of a larger study that examined associations between social anxiety, drinking, and cognitive variables. The present research is the first using this dataset to examine how social anxiety and drinking are associated with interpretation and expectancy biases, and no interpretation/expectancy bias variables were excluded from this report. A full list of materials and tasks is available by contacting the lead author.
2. We want to note that the p-value selected to indicate the threshold for statistical significance varies across the 2 studies. The reason this occurred is that we had initially set the significance threshold at .05 in Study 1, but based on reviewer feedback we subsequently changed it to $p < .01$. Separately, we had decided to use Bonferroni correction to determine the significance threshold for Study 2 (given a different number of tests are conducted in Study 2 vs. Study (1). We elected to leave the slight difference in significance thresholds across studies so we would not be making further changes *post hoc* simply to make them match. We also have tried to attend to magnitude of effects to help guide our interpretation of the results.
3. Because some scenarios presented in the comorbid bias task could be seen as coping with social anxiety via alcohol use whereas others could be seen as pertaining to the negative social effects of drinking, we created two new comorbid interpretation bias scores; one for coping with social anxiety via alcohol use and one for the social effects of drinking. Despite not sharing any common items, the two bias scores were strongly correlated ($r = .512$, $p < .001$). Importantly, we were able to replicate the pattern of results reported in the manuscript. Comorbid bias reflecting coping with social anxiety via alcohol misuse was significantly predicted by a greater severity of comorbid symptoms ($B = .11$, $t = 2.02$, $p = .044$), as well as social anxiety ($B = .26$, $t = 4.86$, $p < .001$) and alcohol use disorder symptoms ($B = .46$, $t = 8.69$, $p < .001$) symptoms. In addition, comorbid bias reflecting the impact of alcohol misuse on social functioning was significantly predicted by a greater severity of comorbid symptoms ($B = .12$, $t = 2.11$, $p = .036$), as well as social anxiety ($B = .45$, $t = 8.14$, $p < .001$) and alcohol use disorder ($B = .49$, $t = 8.78$, $p < .001$) symptoms. Thus, the findings are consistent for biases around social anxiety leading to alcohol misuse and for biases around alcohol misuse worsening social anxiety.

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No potential conflict of interest was reported by the authors.

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Appendix

Alcohol bias

Instructions: During this task, you will see some brief descriptions of situations in which it is not quite clear what is happening. After each one, you will see three possible explanations for the situation. Rate the extent to which you think each of the three explanations for a situation would be likely to be true if you found yourself in that situation.

Use a scale of 0 ("not at all likely") to 8 ("extremely likely") for your ratings. Select a number between 0 and 8 for each of the three explanations in the text.

Response scale:

0	1	2	3	4	5	6	7	8
Not at all likely		A little likely		Moderately likely		Very likely		Extremely likely

1. *You are sitting in the park on a lunch break at work, and hear someone open a can, and you think 'I want one too'. Why?*
_____A refreshing soda would cool you off nicely.
_____You'd love a refreshing beer with lunch.
_____You remember you were supposed to take a Coke over to your co-worker.

2. *After being stuck in traffic on your drive home, you eagerly head to your fridge. Why?*
_____You deserve a glass of wine to unwind.
_____You need to start getting dinner organized because you're hungry.
_____You've been thinking about the leftover dessert from the night before.

3. *You have a long afternoon of home repair projects ahead of you, but decide to stop at the store first. Why?*
_____You want to pick up some pastries because you need a fun snack.
_____You are almost out of paint and glue and don't want to get stuck midway through a repair.
_____A six-pack of beer will make doing the work a lot more fun.

4. *Your alarm goes off after an afternoon nap and the first thing you do is reach for your cup. Why?*
_____You need some coffee in order to get moving.
_____A little alcohol will help you get going.
_____Your mouth is dry and you want some water.

5. *You decide not to go to the gym today. Why?*
_____You had a drink at lunch and don't feel your best.
_____You were up late working and feel too tired.
_____You need to stay late at the office.

6. *You wake up with a bad headache. Why?*
_____You were up late drinking the night before.
_____You've been really stressed at work and need a break.
_____You haven't been drinking enough water and are dehydrated.

7. *A police officer pulls your car over and you start to feel nervous. Why?*
_____You aren't sure if you were speeding.
_____You are worried you'll be late for your meeting now.
_____You've been drinking and could be over the legal limit.

8. *You got into a big fight with your brother last night. Why?*
_____He thinks you drink too much.
_____He made plans with the rest of the family before talking to you.
_____He is irresponsible with money.

Comorbid social anxiety and alcohol interpretation bias

[same instructions and response scale as above]

1. *You arrive at a friend's birthday party and immediately go to the fridge. Why?*
_____ You want a drink so you will have an easier time talking to people.
_____ You're starving because you skipped dinner.
_____ You are thirsty and want to grab a soda.

2. *You're about to go on a first date with someone you really like, but you need to make a quick stop first. Why?*
_____ You need to go to the bathroom.
_____ You want a quick drink so you won't appear so nervous.

_____ You want to be sure your car has enough gas.

3. *You had an extra drink at dinner tonight with friends. Why**?***
_____ You're celebrating completion of a project at work.
_____ You were lost in conversation and didn't notice your glass being refilled.
_____ You noticed you were feeling a little uptight during the conversation.

4. *You don't want to go into work today and try to think of a good excuse to stay home. Why**?***
_____ It's the first day of good weather in weeks, and you want to be outside.
_____ You are behind on a project and know your boss will be mad at you.
_____ You got drunk at the office party last night and are afraid you made a fool of yourself.

5. *Your friend keeps calling you but you don't answer. Why**?***
_____ You have a pile of work to do and can't be tempted into going out.
_____ You said something stupid to her when you'd been drinking and feel too embarrassed to talk to her now.
_____ She keeps talking about her boss and it's getting a bit annoying.

6. *You're listening to a presentation and want to ask a question, but won't do it. Why**?***
_____ You first want to check your notes to see if the answer is there.
_____ You have already asked a couple questions and don't want to speak too much.
_____ You don't feel confident to speak up because you haven't had a drink.

7. *Your sister says she doesn't want to go to the party with you, and suggests a quiet dinner together instead. Why**?***
_____ She doesn't like how much you drink when other people are around.
_____ She is having a problem with her husband and wants to be able to talk with you privately.
_____ She is hungry and wants to sit down.

8. *You just had to give a big presentation at work, and now want to get back to your office and shut the door. Why**?***
_____ You think you blew it and want a drink to steady your nerves.
_____ You have a ton of work to catch up on and don't want to be disturbed.
_____ You want to call your family and tell them how it went.