

**Where's the wine? Heavy social drinkers show attentional bias towards alcohol in a visual conjunction search task.**

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**Abstract:** 299 words

**Main Body:** 3993 words (new method described)

**Figures:** 2

**Tables:** 4

**Supporting Information Files:** 2

**Data Availability Statement:** The pre-registration protocol, data and supporting information files for this study are available via the Open Science Framework (OSF): <https://osf.io/46sn8/>

**Funding:** None.

**Conflict of Interest:** None.

**Abstract**

**Background and Aims:** Research indicates that high consumers of alcohol exhibit attentional bias (AB) towards alcohol-related cues, suggestive of a cognitive mechanism that might drive substance seeking. Many tasks that measure AB (e.g., visual probe, addiction Stroop), however, are limited by their reliance on non-appetitive control cues, the serial presentation of stimuli, and their poor internal reliability. The current study employed a visual conjunction search (VCS) task capable of presenting multiple alcoholic and non-alcoholic appetitive cues simultaneously to assess whether social drinkers attend selectively to alcoholic stimuli. To assess the construct validity of this task, we examined whether alcohol consumption and related problems, subjective craving, and drinking motives predict alcohol-specific AB. **Design & Setting:** A VCS task was performed in a laboratory setting, which required participants to detect the presence of appetitive alcoholic (wine, beer) and non-alcoholic (cola, lemonade) targets within arrays of matching and non-matching distractors. **Participants:** Data from 99 participants were assessed ( $M_{Age} = 20.77$ ,  $SD = 2.98$ ; 64 [65%] females), with 81.8% meeting the threshold for harmful alcohol consumption ( $M_{AUDIT} = 12.89$ ,  $SD = 5.79$ ). **Measurements:** Self-reports of alcohol consumption and related problems (AUDIT), subjective craving (Alcohol Craving Questionnaire Short Form) and drinking motives (Drinking Motives Questionnaire Short Form) were obtained, and the VCS task measured response times for the correct detection of alcoholic and non-alcoholic targets. **Findings:** Participants were significantly quicker to detect alcoholic relative to non-alcoholic appetitive targets ( $p < .001$ ,  $d_z = .41$ ), which was predicted positively by AUDIT scores ( $p = .013$ ,  $R^2 = .06\%$ ). The VCS task achieved excellent reliability ( $\alpha > .79$ ), superior to other paradigms. **Conclusions:** The Visual Conjunction Search task presents as a highly reliable method for assessing alcohol-related attentional bias, and shows that heavy social drinkers prioritise alcoholic cues in their immediate environment.

**Key words:** Alcohol consumption; AUDIT; attentional bias; visual search; visual attention; subjective craving; drinking motives.

**Where's the wine? Heavy social drinkers show attentional bias towards alcohol in a visual conjunction search task.**

A vast corpus of research indicates that heavy social drinkers allocate their attention selectively towards alcohol-related cues (see 1 for review). This attentional bias (AB) towards alcohol is believed to reflect enhanced neural signalling for cues associated with substances administered repeatedly, and the degree to which an individual exhibits alcohol-related AB is suggested to be an important predictor of substance seeking and relapse risk (2). In this light, it is essential to develop tools for the accurate and reliable measurement of AB; only then can we begin to advance our understanding of the relationship between alcohol-related AB and harmful alcohol consumption and assess the effectiveness of interventions.

Alcohol-related AB has been demonstrated with a variety of experimental paradigms, including the addiction Stroop (3–8), visual probe (9–12), anti-saccade (13,14) and gaze contingency task (15,16). On the visual probe task, alcohol users respond faster to probes appearing in locations occupied previously by alcohol-related compared to non-alcoholic stimuli, suggesting their attention is drawn to the spatial location of alcoholic cues (1). Moreover, AB on this task appears to be moderated by alcohol use, with heavy social drinkers demonstrating greater alcohol-related AB compared with lighter drinkers (12,17). Similarly, studies employing the addiction Stroop task report that heavy drinkers and alcohol-dependent individuals are slower to name the colour in which alcohol-related words are presented relative to control words (4,6–8,18–20). The findings of studies employing these two tasks therefore converge to suggest that individuals who consume alcohol regularly demonstrate preferential processing of alcohol-related stimuli.

In recent years, however, both the visual probe and addiction Stroop task have come under increasing criticism for their low internal and test-retest reliability (21–23). It has also

## ALCOHOL-RELATED ATTENTIONAL BIAS

been argued that the type of stimuli used in experimental paradigms may exaggerate the degree to which AB towards alcohol is shown (24). Some studies, for example, assess alcohol-related AB by comparing responses between alcoholic *appetitive* stimuli and non-alcoholic *non-appetitive* control stimuli (e.g., office stationary; 13,16,25–28). By only using non-appetitive control cues, it is impossible to dissociate between alcohol-specific AB or a more generalised response bias towards appetitive stimuli imbued with incentive value (see 1). Indeed, a number of studies have demonstrated the importance of using appetitive non-alcoholic control stimuli to investigate alcohol-related cognitions (14,24,29–32). Finally, experimental measures of AB towards alcoholic cues often present participants with (non-)alcoholic stimuli in a sequential manner that fails to capture an important aspect of real-world contexts: In naturalistic environments (e.g., pubs and bars), multiple contrasting cues will place demands on visual attention simultaneously. In the addition Stroop and anti-saccade tasks, however, individuals respond to single items presented successively, and in the visual probe task they respond to a probe after the presentation of a singular pair of alcoholic and control stimuli. It remains to be seen, then, whether alcohol users demonstrate AB towards alcohol even when multiple non-alcoholic appetitive distractors are present.

These methodological limitations are overcome with visual search paradigms that afford the presentation of multiple matched alcoholic and non-alcoholic appetitive cues. The visual conjunction search (VCS) task requires individuals to scan a stimulus array for a pre-specified target positioned among multiple matching and non-matching distractor images. In comparison to feature searches, in which targets appear to “pop out” by virtue of a single distinguishing characteristic, detection of the target in conjunction search demands more attentional resources because it shares one or more common features with the distractors. Given this high visual similarity, participants must use prior knowledge of target characteristics to maximise search efficiency (33–35). This task may therefore offer an effective method for

## ALCOHOL-RELATED ATTENTIONAL BIAS

assessing alcohol-related AB and substance-related AB more generally; through repeated alcohol use, characteristic features of alcoholic cues may elicit enhanced signalling that leads to their prioritised detection among other stimuli in the environment (24). This aligns with the incentive-sensitisation theory of addiction (36–38), which proposes that, through neurophysiological changes, increased familiarity with substance-related cues heightens their incentive motivational properties (1,39,40). Despite their potential utility, we are aware of only one prior use of the VCS task to assess alcohol-related AB. In a previous experiment (24), we asked social drinkers to identify either an alcoholic (beer), appetitive non-alcoholic (water) or non-appetitive target (detergent) in an array of matching and mismatching distractors. Participants exhibited faster responses to both alcoholic and non-alcoholic relative to non-appetitive targets. At first glance, this appears to reveal generalised AB towards appetitive stimuli. However, it is equally possible that by pairing appetitive non-alcoholic targets with non-appetitive repellent distractors in the same scene, we inadvertently masked alcohol-related AB with an approach bias towards palatable non-alcoholic stimuli.

Overcoming the aforementioned issues of previous research, the first aim of the current study was to examine whether alcohol users exhibit AB towards alcoholic (e.g., wine) relative to matched appetitive non-alcoholic stimuli (e.g., cola) using a novel VCS task. It was hypothesised that social drinkers would exhibit greater AB towards alcohol relative to non-alcohol, indexed by faster reaction times to detect the presence of alcoholic targets. To assess the construct validity of this task, the second aim was to examine whether self-reported alcohol consumption and related problems, subjective craving and drinking motives predicted alcohol-related AB. Previous research suggests that the degree to which individuals demonstrate alcohol-related AB is proportional to the amount of alcohol they consume habitually (e.g., 4,12,41–43). Similarly, studies report a reliable association between subjective craving and AB, whereby heightened craving leads to attentional capture by associated cues until the

## ALCOHOL-RELATED ATTENTIONAL BIAS

substance is consumed (e.g., 10,44–46). Drinking motives refer to the particular valued outcomes that people associate with drinking (e.g., social, enhancement, coping, conformity; 47,48), and studies indicate that these serve as a unique predictor of drinking behaviour; whilst coping motives are related to alcohol-related consequences (e.g., impaired control), social and enhancement motives are related to higher levels of consumption (49–54). Driven by this research, we hypothesised that alcohol consumption and related problems (AUDIT), subjective craving and drinking motives would each predict alcohol-related AB positively and independently.

## Method

### Data Availability Statement

The pre-registration protocol, data, and supporting information files are available via <https://osf.io/46sn8/>.

### Design

Participants completed a visual conjunction search (VCS) task comprising a 2 (Target: Alcoholic vs. Non-alcoholic) x 2 (Presence: Present vs. Absent) within-participant design, and three self-report questionnaires. An a-priori power analysis (G\*Power; 55) indicated that a sample size of 88 was required to detect a moderate main effect of Target (Cohen's  $d = .50$ ,  $d_z = .35$ ) with 90% power at  $\alpha = .05$ . However, a minimum sample of 100 participants was planned in order to allow students to collect course credits by the end of the university term and to ensure we met guidelines proposed for regression analyses (i.e.,  $50 + 8k$ ; 56,57).

### Participants

## ALCOHOL-RELATED ATTENTIONAL BIAS

Data from a total of 129 participants were collected because, unexpectedly, 27 participants were excluded for achieving less than 50% accuracy on the VCS task. Given that accuracy is typically very high on this task (33,35), such poor performance indicates a misunderstanding of instructions or lack of concentration. Additionally, two participants were excluded because they reported not drinking alcohol (i.e. AUDIT score of zero) and one responded inconsistently. Importantly, these exclusions do not alter the reported findings (see File S1). The final sample included 99 participants (64 [65%] females) aged 18-45 years ( $M_{age} = 20.77$ ,  $SD = 2.98$ ), all of whom reported normal or corrected-to-normal vision. With a mean AUDIT score of 12.89 ( $SD = 5.79$ , range 3-30), and 81.8% meeting the threshold for harmful alcohol use (score > 8; 58), this sample was comprised predominantly of heavy social drinkers.

Ethical approval was granted by the Faculty Research Ethics Committee and all individuals provided informed consent prior to commencing the experiment.

### **Measures**

The VCS task and self-report questionnaires were administered through the Cogent toolbox for MATLAB (MathsWorks, Natick, MA).

#### *Visual Conjunction Search Task*

The VCS task required participants to detect whether a left-hanging target (alcoholic or non-alcoholic) was present or absent within an array of alcoholic and non-alcoholic distractors. Four images of branded alcoholic (beer or red wine) and non-alcoholic beverages (lemonade or cola) were selected from the Amsterdam Beverage Picture Set (59) – a validated battery of alcoholic and non-alcoholic stimuli. These stimuli were matched according to the normative ratings reported by Pronk et al. (59) based on context and sub-content (single bottles with no contextual cues) and product familiarity (> 90%; “Do you know this beverage?” and “Have

## ALCOHOL-RELATED ATTENTIONAL BIAS

you ever consumed this beverage?" [Yes/No]). Search arrays were then created comprising alcoholic and non-alcoholic stimuli that were equivalent in terms of their dominant colour and luminosity. In arrays containing alcoholic targets, participants were instructed to detect the presence/absence of a left-hanging green beer bottle amongst distractors of matching beer bottles and mismatching green lemonade bottles; or a red wine bottle amongst an array of red cola distractors. These instructions were reversed for the non-alcohol target trials. Stimulus arrays were displayed on an invisible 4 x 6 grid containing 24 items. The target and half of the non-matching distractor images were rotated 45 degrees to the left (see Figure 1).

[INSERT FIGURE 1 HERE]

In line with Biggs, Clark and Mitroff (60), there were four blocks of 32 trials. The same trial type was presented throughout each block, defined by the target-distractor combination (wine, beer, cola, lemonade). The order of the 32 trials were randomised within blocks, with the target present on 50% of trials. Trials began with a black fixation cross presented for 500ms, after which the search array was displayed until a response was recorded. Participants responded to each trial by clicking directly on the target location with the computer mouse when it was present, and clicking anywhere within the black background surrounding the array when it was absent. The cursor reset to the centre of the computer screen at the beginning of each trial. Mouse clicks were coded according to their  $x$ - $y$  screen co-ordinates, and correct responses were recorded by predefined boundaries. The dependent variable was reaction time (RT) in seconds for correct responses, collapsed across the two *alcoholic* (wine and beer) and *non-alcoholic* target blocks (lemonade and cola). Quicker RT was used as an index of AB.

Further controls were implemented to ensure that search performance between the alcoholic and non-alcoholic stimuli was not confounded by target placement. Specifically,



## ALCOHOL-RELATED ATTENTIONAL BIAS

search arrays were designed such that the randomisation of alcoholic and non-alcoholic target positions were matched (e.g., in a trial where an alcoholic target appeared on the third column of the first row, there would be an exact match of this using a non-alcoholic target). The target was never presented on the first column of the first row, and each stimulus was presented equally on one of the four rows (i.e. in random order, each target appeared eight times in each row). To control for order effects, the task was counterbalanced so that each participant started on a block of alcoholic or non-alcoholic target trials.

### *Questionnaires*

#### *Alcohol Consumption*

The Alcohol Use Disorders Identification Test (AUDIT; 61) is a 10-item screening tool used to assess harmful and hazardous alcohol consumption, drinking behaviours, and alcohol-related problems. This questionnaire achieved acceptable internal reliability (McDonalds's  $\omega = .82$ ; Cronbach's  $\alpha = .78$ ) and a total score ranging from 0–40 was calculated.

#### *Subjective Craving*

The Alcohol Craving Questionnaire Short Form (ACQ-SF-R; 62,63) includes 12-items that assess subjective craving. This also achieved acceptable internal reliability ( $\omega = .86$ ;  $\alpha = .85$ ) and a total score ranging from 12-84 was calculated.

#### *Drinking Motives*

The Drinking Motives Questionnaire Short Form (DMQ-R-SF; 47,64) includes 12-items that assess participants' motivations for drinking alcohol through four sub-scales; social (positive social rewards), coping (dealing with negative emotions), enhancement (positive mood), and conformity (fitting in with peers). This questionnaire achieved high internal

## ALCOHOL-RELATED ATTENTIONAL BIAS

reliability when considering all items together ( $\omega = .82$ ;  $\alpha = .81$ ), and those relating specifically to the Social ( $\omega = .85$ ;  $\alpha = .85$ ), Coping ( $\omega = .84$ ;  $\alpha = .83$ ), Enhancement ( $\omega = .73$ ;  $\alpha = .70$ ) and Conformity sub-scales ( $\omega = .77$ ;  $\alpha = .77$ ). The mean frequency for each motive was calculated separately with a possible range of 3-15.

### **Procedure**

Participants always completed the AUDIT, ACQ-SF-R and DMQ-R-SF questionnaires before the VCS task, allowing us to examine if subjective craving predicted alcohol-related AB rather than the influence of alcohol-related images on subjective craving (65). The order of both blocks of the VCS task (alcohol or non-alcohol target blocks) and the questionnaires were counterbalanced between participants, however. Participants were seated 57cm away from the computer monitor throughout the procedure. Upon completion of the study, participants received a full debrief.

### **Analytic Strategy**

As expected, accuracy on the VCS task was high (>95%) and so analyses focused on RT. To assess whether participants demonstrated AB towards alcohol, we conducted a 2 (Target: Alcoholic vs. Non-alcoholic) x 2 (Presence: Present vs. Absent) repeated measures Analysis of Variance (ANOVA) on RT. All main effects and interactions were analysed with Bonferroni corrections, and effect sizes are reported as partial eta squared and Cohen's  $d_z$ . Values present condition means ( $\pm$ SD) and 95% confidence intervals for mean differences ( $CI_{diff}$ ). Next, a hierarchical multiple regression analysis was conducted to examine whether alcohol consumption and related problems (AUDIT; step 1), subjective craving (ACQ-SF-R; step 2) and drinking motives (DMQ-R-SF; step 3) predicted alcohol-related AB. Here, a mean difference score was calculated by subtracting RT to alcoholic stimuli from non-alcoholic

## ALCOHOL-RELATED ATTENTIONAL BIAS

stimuli, with positive scores indicative of alcohol-related AB. Although predictor variables were correlated, variance inflation factors ( $< 1.50$ ) and tolerance statistics suggested that multicollinearity was negligible. Furthermore, all predictors and outcomes met assumptions of normality. It is important to note that as a deviation from the pre-registration, the regression analysis entered the four sub-scales of the DMQ-R-SF separately (see File S1).

### Results

Internal reliabilities for the VCS task are shown in Table 1. Using the Cocron application (66), we performed statistical comparisons between these estimates of internal reliability and those reported in previous research using the visual probe and addiction Stroop tasks (21,23; see File S2). This revealed that our VCS task significantly outperformed 69% of these former studies.

[INSERT TABLE 1 HERE]

Data from two participants on the VCS task were beyond 3 standard deviations of the sample mean and were replaced with the next lowest or highest score in the dataset (55). In line with predictions, there was a significant main effect of Target ( $F[1, 98] = 18.00, p < .001, \eta_p^2 = .16$ ), with participants quicker to identify alcoholic relative to non-alcoholic targets (2.53 [ $\pm .50$ ] vs. 2.68 [ $\pm .60$ ] sec;  $CI_{diff} = [-.23, -.08]; p < .001, d_z = .41$ ). There was also a significant main effect of Presence ( $F[1, 98] = 263.16, p < .001, \eta_p^2 = .73$ ), with participants quicker to detect the target when it was present relative to absent (2.12 [ $\pm .30$ ] vs. 3.09 [ $\pm .79$ ] sec;  $CI_{diff} = [-1.09, -.85]; p < .001, d_z = 1.64$ ). The two-way interaction between Target and Presence was inconclusive ( $p > .05$ ) and mirrored the main effects; response times were quicker for both present and absent alcoholic relative to non-alcoholic stimuli ( $ps < .01$ ), and quicker for present

## ALCOHOL-RELATED ATTENTIONAL BIAS

relative to absent stimuli ( $ps < .001$ ). One-sample  $t$ -tests on all dependent variables indicative of AB differed significantly from zero ( $ps < .001$ ). Table 2 presents descriptive statistics.

[INSERT TABLE 2 HERE]

The regression revealed that alcohol consumption and related problems (AUDIT) predicted alcohol-related AB positively ( $\beta = .25$ ;  $F[1, 97] = 6.47$ ,  $p = .013$ ,  $R^2 = .06\%$ ). This relationship is illustrated in Figure 2. Contrary to predictions, subjective craving and drinking motives did not account significantly for additional variance ( $ps > .05$ ). Table 3 presents the regression matrix.

[INSERT FIGURE 2 HERE]

[INSERT TABLE 3 HERE]

*Exploratory Analyses*

Given the results of our confirmatory analyses, we examined the relationships between alcohol consumption (AUDIT), subjective craving (ACQ-SF-R), drinking motives (DMQ-R-SF) and alcohol-related AB independently of each other. Table 4 presents the correlation matrix. Interestingly, this revealed that alcohol use, subjective craving and social drinking motives each showed a weak but significant positive relationship with alcohol-related AB ( $p < .028$ ). In a data-driven approach, we then conducted separate regression analyses with alcohol consumption, subjective craving and social drinking motives entered as independent predictors of alcohol-related AB. This confirmed that each predictor significantly explained 4-5% of variance in alcohol-related AB exhibited on the VCS task. This suggests that each of these

## ALCOHOL-RELATED ATTENTIONAL BIAS

measures account for similar variance in AB towards alcohol; however, when entered in a hypothesis-driven hierarchical fashion, subjective craving and social drinking motives do not significantly explain *additional* variance in alcohol-related AB than alcohol consumption and related problems (AUDIT) do alone.

[INSERT TABLE 4 HERE]

### Discussion

Uncovering the cognitive mechanisms that drive alcohol misuse is central to addiction research, facilitating the development of interventions capable of reducing such behaviour (for reviews see 1,2,40). In the present study, we evaluated the effectiveness of the visual conjunction search (VCS) task for measuring attentional bias (AB) towards alcohol – a cognitive mechanism believed to drive substance seeking and increase the risk of relapse (2). Our investigation demonstrated the high reliability and validity of this measure of alcohol-related AB; performance on the VCS task was itself predictive of, and associated with other known predictors of alcohol consumption. We argue, therefore, that this simple experimental task provides an accurate assessment of AB towards alcoholic cues, whilst also overcoming some fundamental methodological limitations of studies in this field.

Previous studies claim to demonstrate how alcohol users' visual attention is captured by alcohol-related cues through use of the addiction Stroop (3–8), visual probe (9–12), anti-saccade (13,14) and gaze contingency task (15,16). Closer inspection of some of these investigations reveals fundamental methodological issues that may provide an inaccurate picture of alcohol-related cognition, however. Some demonstrations of alcohol-related AB have contrasted responses between alcoholic and non-alcoholic *non-appetitive* stimuli (e.g., 13,16,25–28). The use of such control stimuli renders it difficult to conclude that responses are

## ALCOHOL-RELATED ATTENTIONAL BIAS

due to the ‘substance-relatedness’ of stimuli rather than a more general appetitive response bias (for a related discussion see 1), and may lead to inflated estimates of the magnitude of alcohol-related AB. Moreover, the addiction Stroop and visual probe task have been criticised for their poor reliability (21–23) and the sequential manner in which stimuli are presented (24,30). We have shown that the VCS task achieves estimates of reliability that are markedly higher than these other tasks. Further, the simultaneous presentation of multiple alcoholic and non-alcoholic appetitive stimuli may capture how visual attention plays out in real-world environments more accurately. Thus, we contend that this paradigm proffers a more robust measurement of alcohol-specific AB, and may prove useful in future studies that seek accurate assessment of AB towards other substances.

Building on the premise that repeat alcohol use may lead to enhanced signalling of alcohol-related cues (24), we hypothesised that alcohol users would exhibit AB towards alcoholic relative to non-alcoholic cues on the VCS task. Consistent with this, our sample of heavy social drinkers were quicker to detect the presence of alcoholic appetitive cues in an array of alcoholic and non-alcoholic distractors. These findings can be interpreted through the lenses of two theories: the incentive-sensitisation theory of addiction (36–38) and the more general feature integration theory of visual search (33,34). The former suggests that through repeat consumption, alcohol-related cues acquire incentive-motivational properties that bias attentional processing towards alcoholic cues. The second suggests that visual search efficiency is enhanced through prior experience with, and knowledge of, target stimuli. Synthesising these accounts, our findings suggest that individuals who consume alcohol habitually may prioritise the detection of alcoholic stimuli in their immediate environment. These theories could be tested directly by personalising the stimuli used in the VCS task to reflect participants’ beverage preference (see 67,68). If their primary tenets hold true, individuals who drink beer

## ALCOHOL-RELATED ATTENTIONAL BIAS

most regularly, for example, should exhibit greater AB towards this beverage relative to one that is less preferred.

At first glance, the findings of the present study seem to contrast with our previous experiment; using a similar VCS task, we observed generalised AB towards both alcoholic and non-alcoholic appetitive stimuli (24). It is important to highlight two key differences between these studies that may reconcile the discrepant findings. First, our previous design included a second control condition of non-appetitive stimuli (cleaning detergent) that may have heightened participants' approach bias towards non-alcoholic appetitive stimuli unintentionally, masking any subtle alcohol-specific AB. Second, our previous study involved a sample of light social drinkers with a mean AUDIT score of 6.5 and only 27% scoring above the clinical cut off of 8.0 (58). This differs strikingly from the sample of heavy social drinkers assessed in the present study; over 80% of the sample exceeded the threshold for harmful alcohol use, producing a mean AUDIT score of 12.9. Indeed, prior research indicates that heavy drinkers demonstrate greater alcohol-related AB than lighter drinkers (12,17), so it is likely that these contrasting results reflect heterogeneity in participants' alcohol consumption and drink-related behaviours. Future research could investigate this by using our VCS task to compare alcohol-related AB between heavy and light drinkers, the latter of whom may not be so familiar with alcohol.

A second aim of the current study was to examine whether individual differences in alcohol consumption and related problems, subjective craving and drinking motives predicted AB towards alcohol. Findings indicated that AUDIT scores explained a small yet significant proportion of variability in alcohol-related AB. This serves to validate our task for the assessment of alcohol-related AB, as well as providing further evidence for this association (see 4,12,41–43). Against predictions, however, subjective craving and drinking motives did not explain any unique variance in alcohol-related AB. In a meta-analysis of 68 studies, Field

## ALCOHOL-RELATED ATTENTIONAL BIAS

et al. (40) report a weak but robust ( $r = .19$ ) positive relationship between craving and AB towards alcohol. Past research has also suggested that drinking motives are a unique predictor of alcohol consumption and related problems (49,50,52–54). To probe this finding further, we conducted exploratory analyses to examine whether alcohol consumption, craving and social drinking motives predicted alcohol-related AB when they were entered into separate regression models. This indicated that each predictor explained between 4-5% of variance in alcohol-related AB and showed moderate to strong correlations among themselves. However, when entered in a hierarchical fashion (as per confirmatory analyses), subjective craving and social drinking motives did not explain *additional* variance in alcohol-related AB than AUDIT scores alone. Further research should not be deterred from exploring these three potential predictors of alcohol-related AB more closely.

It is important to acknowledge some potential limitations of our experiment that can be addressed in future studies. First, to avoid any influence of alcohol-related images on measures of subjective craving (65), we administered all questionnaires before the VCS task. In doing so, however, we may have introduced the reverse order effect; self-reported craving may have influenced alcohol-related AB. This could be avoided easily by counterbalancing. Second, given the high proportion of students in the present sample who met the threshold for harmful alcohol use and related problems, future research should assess whether our findings extend to (non-student) samples reporting lower alcohol consumption or non-drinkers. Relatedly, further studies are needed to identify other sources of individual differences in AB towards alcohol; for example, while we have revealed that AUDIT scores are an important predictor, we did not consider other factors that might exert a confounding influence on this relationship (e.g., socio-demographic).

**Conclusion**



## ALCOHOL-RELATED ATTENTIONAL BIAS

The current study presents the utility of the VCS task with carefully matched appetitive alcoholic and non-alcoholic stimuli for the assessment of AB towards alcoholic cues. We introduce a reliable and valid experimental measure of alcohol-related AB that captures more accurately how this cognitive process might influence visual attention in real-world contexts. Our findings serve as recommendations for future research in this area: First, it is paramount that researchers employ matched alcoholic and non-alcoholic stimuli if we are to conclude unequivocally that AB is driven by ‘substance-relatedness’. Second, researchers must report more openly the reliability of experimental paradigms so that accurate inferences can be made regarding alcohol-related AB. Given the versatility of the VCS task, we welcome future studies to consider its use to uncover the attentional processes that may underpin substance (mis)use.

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## ALCOHOL-RELATED ATTENTIONAL BIAS

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## ALCOHOL-RELATED ATTENTIONAL BIAS

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## ALCOHOL-RELATED ATTENTIONAL BIAS

Table 1.

*Internal reliability (McDonalds's  $\omega$  and Cronbach's  $\alpha$ ) for RT on the VCS task as a function of Target and Presence.*

Target	Presence			
	Present		Absent	
	$\omega$	$\alpha$	$\omega$	$\alpha$
Alcoholic	0.83	0.79	0.97	0.97
Non-alcoholic	0.89	0.82	0.97	0.97

**Note:** *Each factor combination (e.g., Alcoholic-Present) consists of 32-items.*

## ALCOHOL-RELATED ATTENTIONAL BIAS

Table 2.

*Descriptive statistics for RT on the VCS task as a function of Target and Presence.*

	<b>Presence</b>		
	Present	Absent	Total
<b>Target</b>	<i>M (SD)</i>		
Alcoholic	2.02 (0.31)	3.03 (0.77)	2.53 (0.50) <sup>a</sup>
Non-alcoholic	2.21 (0.39)	3.15 (0.89)	2.68 (0.60) <sup>a</sup>
Total	2.12 (0.30) <sup>b</sup>	3.09 (0.79) <sup>b</sup>	--

**Note:** Common sub-scripts denote statistically significant differences,  $p < .050$ .

## ALCOHOL-RELATED ATTENTIONAL BIAS

Table 3.

*Alcohol consumption, subjective craving and drinking motives regressed on alcohol-related AB.*

Variable	Step 1 <i>p</i> = .013, $\Delta R^2 = .06^*$				Step 2 <i>p</i> = .272, $\Delta R^2 = .06$				Step 3 <i>p</i> = .119, $\Delta R^2 = .09$			
	<i>b</i>	95% CI	<i>SE</i>	$\beta$	<i>b</i>	95% CI	<i>SE</i>	$\beta$	<i>b</i>	95% CI	<i>SE</i>	$\beta$
AUDIT Alcohol consumption	.02	.003, .03	.006	.25*	.01	-.003, .30	.007	.19	.01	-.006, .03	.008	.16
ACQ-SF-R Craving					.004	-.003, .01	.003	.13	.005	-.002, .01	.003	.16
DMQ-R-SF Enhancement									-.03	-.12, .06	.04	-.08
Social									.11	.005, .21	.05	.24*
Coping									-.08	-.16, .004	.04	-.20
Conformity									-.02	-.12, .09	.05	-.04

**Note:** 95% CI of *b*. AUDIT = Alcohol Use Disorders Identification Test; ACQ-SF-R = Alcohol Craving Questionnaire Short-Form Revised; DMQ-R-SF = Drinking Motives Questionnaire Revised Short-Form.

## ALCOHOL-RELATED ATTENTIONAL BIAS

Table 4.

*Matrix of unadjusted regression coefficients ( $\beta$ ) between self-report instruments and VCS task performance.*

	1.	2.	3 <sub>a</sub> .	3 <sub>b</sub> .	3 <sub>c</sub> .	3 <sub>d</sub> .	4.
1. Alcohol consumption (AUDIT)	--						
2. Subjective craving (ACQ)	.51***	--					
3 <sub>a</sub> . Enhancement Motives (DMQ)	.45***	.32**	--				
3 <sub>b</sub> . Social Motives	.41***	.31**	.50***	--			
3 <sub>c</sub> . Coping Motives	.19	.26**	.12	.20*	--		
3 <sub>d</sub> . Conformity Motives	.49***	.51***	.30**	.30**	.32**	--	
4. Alcohol-related AB (VCS Task)	.25*	.22*	.13	.27**	-.09	.11	--

**Note:** \*\*\*  $p < .001$ , \*\*  $p < .010$ , \*  $p < .050$ .

## ALCOHOL-RELATED ATTENTIONAL BIAS

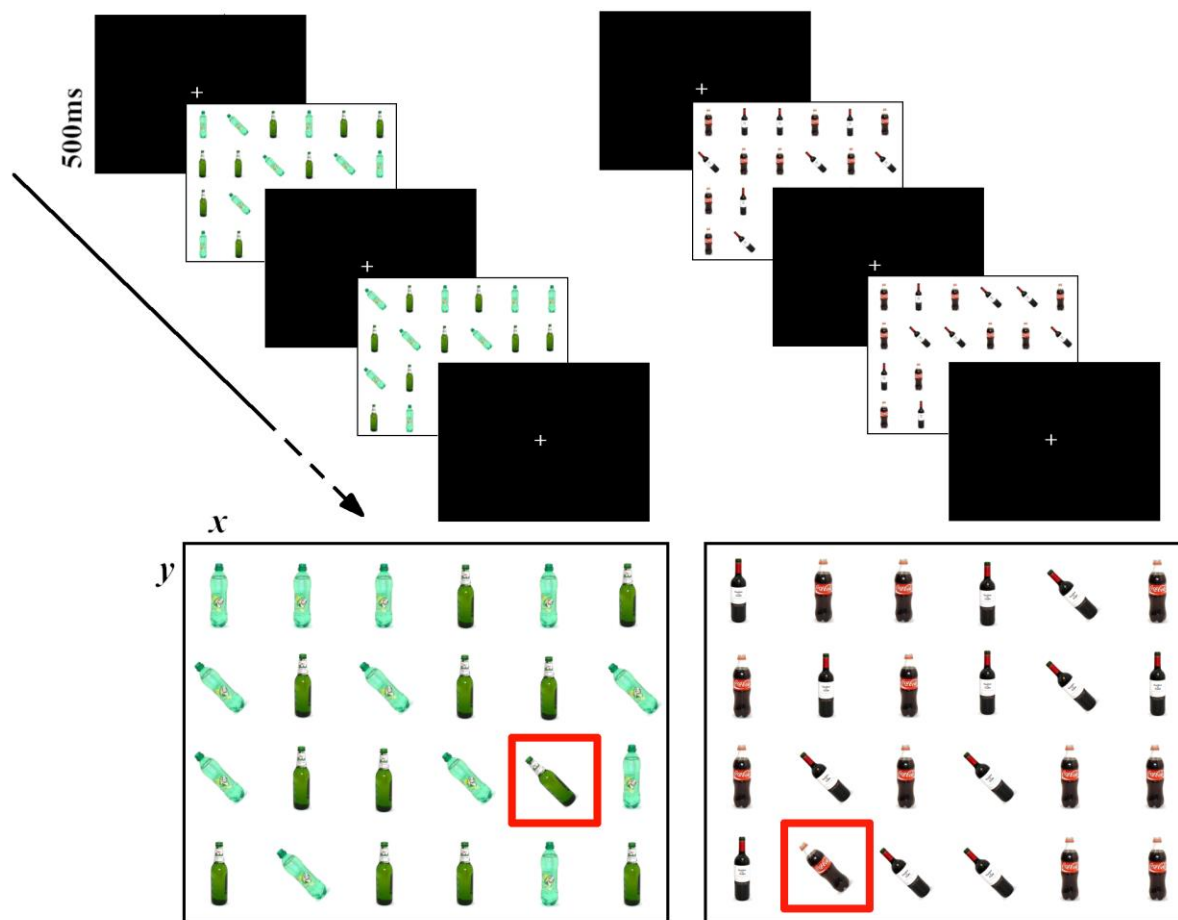
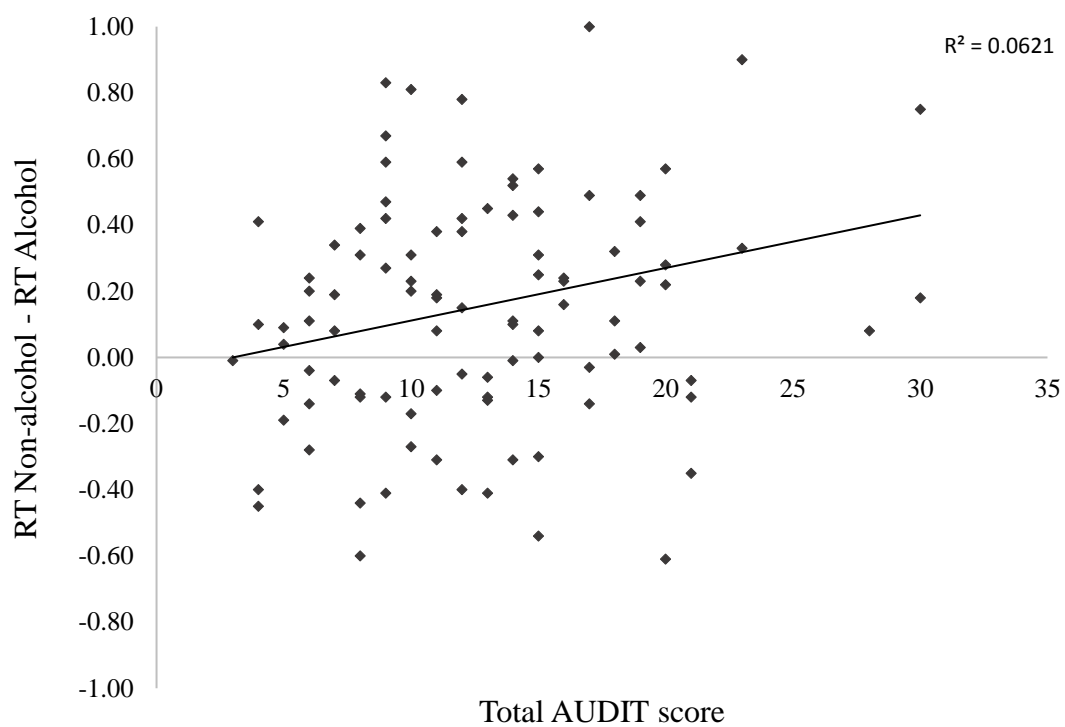


Figure 1. Experimental stimuli. Example arrays presented on one of the two alcoholic (*left*) and non-alcoholic blocks (*right*), demonstrating Present trials (targets highlighted red). Responses were recorded as  $x$ - $y$  axis locations.

## ALCOHOL-RELATED ATTENTIONAL BIAS



*Figure 2.* Scatterplot showing the relationship between self-reported alcohol consumption (AUDIT scores) and alcohol-related AB on the VCS task.