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THE EFFECTS OF ALCOHOL CUE EXPOSURE ON NON-DEPENDENT DRINKERS' ATTENTIONAL BIAS FOR ALCOHOL-RELATED STIMULI

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Abstract — **Aims:** The effects of university students' habitual drinking practices and experimental alcohol cue exposure on their attentional bias for alcohol-related stimuli were assessed. **Methods:** Participants were exposed *in vivo* to either an alcoholic or non-alcoholic beverage immediately prior to completing a cognitively demanding emotional Stroop task that uses alcohol-related and control words as potential distractors. **Results:** Regression analyses indicated that, for participants who were low consumers of alcohol, neither level of habitual drinking, type of cue exposure, nor their interaction predicted attentional bias for the alcohol-related stimuli. For high consumers of alcohol who were exposed to the alcoholic beverage (but not those exposed to the non-alcoholic beverage), the amount of alcohol that participants habitually drank significantly predicted the degree of attentional bias. **Conclusions:** The results indicate that, among non-dependent drinkers (unlike alcohol-dependent participants), alcohol-related attentional bias is not a generalized phenomenon, but occurs only under a specific set of circumstances.

INTRODUCTION

Attentional bias for disorder-related stimuli has been shown to play a major role in the maintenance of certain kinds of psychopathology. In the laboratory, the emotional Stroop paradigm has been the most commonly used technique for investigating this bias (Williams *et al*., 1996). This method uses categories of distracting stimuli that have emotional relevance with the disorder being studied. In the emotional Stroop test, the participant is instructed to ignore the meanings of the words and concentrate only on naming the colour in which the word is written. Typically, participants are slower to colour name words related to their disorder than words of neutral emotional valence. This phenomenon is known as the emotional Stroop effect.

Previous research using the information-processing paradigms has demonstrated attentional biases related to several kinds of addictive behaviours. Participants have included methadone-maintained opiate addicts (Lubman *et al*., 2000), smokers (Waters and Feyerabend, 2000) and gamblers (McCusker and Gettings, 1997). In addition, alcohol-dependent participants' attentional bias for alcohol-related stimuli has been demonstrated in a number of studies (Johnsen *et al*., 1994; Stetter *et al*., 1995; Bauer and Cox, 1998; Cox *et al*., 2000; Stormark *et al*., 2000; Sharma *et al*., 2001). In the Lubman *et al*. (2000) study, a dot-probe task was used to assess participants' attentional bias for pictorial stimuli associated with drug use. Pairs of pictures were presented simultaneously, followed by a small dot probe in the location that one of the pictures had just occupied. Compared to controls, the opiate addicts displayed faster reaction times to probes appearing in the location of the drug-related pictures than those appearing in the location of neutral pictures. Weinstein *et al*. (2001), on the other hand, used a contextual priming task with alcohol-dependent participants in which craving- or withdrawal-related sentences were used as the primes, with alcohol-related or alcohol-unrelated words or non-words as the probes. Results indicated that only the alcohol-dependent participants who were recently detoxified (up to 2 weeks earlier) were impaired when they processed the alcohol-related words. Similarly, Bauer and Cox (1998) found that in-patient alcohol-dependent drinkers who had been recently detoxified were more distracted by alcohol-related stimuli than by stimuli of general positive or negative emotional valence. Moreover, in this study, the dependent drinkers responded significantly slower to all categories of stimuli than did non-dependent drinkers, suggesting more cognitive impairment in the dependent drinkers.

These findings accord well with other results which suggest that dependent drinkers exhibit greater interference in cognitive processing than non-dependent drinkers, when the distracting information is alcohol-related (Johnsen *et al*., 1994), and that the more dependent drinkers focus their attention on the content of alcohol-related words, the more difficult it becomes for them to shift their attention to the colour of these words (Stormark *et al*., 2000). Despite the apparent consistency of these findings, the use of the Stroop task specifically to investigate cognitive mechanisms that underlie the motivation to drink is still in its infancy, and the particular circumstances that give rise to selective attention for alcohol-related stimuli have not been clearly delineated. If it can be established that alcohol attentional biases are associated with the severity and course of alcohol dependence, their use might help to improve diagnosis and treatment and the monitoring of treatment outcomes.

A variable that is likely to potentiate alcohol attentional bias is alcohol cue exposure. For example, Sayette *et al*. (1994) found that, when dependent drinkers were exposed to alcohol cues, their performance on a cognitive task that required their attention was impaired. This outcome supports the theoretical view (Tiffany, 1990) that cue reactivity is governed by automatic cognitive processes (namely memories of alcohol use) that interfere with performance on tasks requiring controlled processing. When dependent drinkers are exposed to alcohol stimuli (e.g. the sight and smell of a preferred beverage), these automatic processes are activated and are likely to lead to a virtually effortless act of drinking. That is, with repeated practice, the act of drinking becomes increasingly well-learned, and by the time drinkers have become alcohol-dependent, their drinking behaviour has become automatized. An example that

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Tiffany (1990) gave is that of the drinker who goes through the act of getting up from a living-room chair, walking into the kitchen, opening the refrigerator, removing a beer, twisting off the cap, lifting the bottle, and taking the drink, all of which may require virtually no cognitive effort for someone who has performed this sequence of actions many times before. Hence, behaviour that previously required considerable attention and concentration can now be carried out rapidly and accurately, with little or no awareness of the component actions. Because alcohol cue exposure appears to cause drinkers automatically to allocate their attentional resources disproportionately to alcohol-related stimuli, while simultaneously focusing their attention away from other stimuli that require controlled processing, we hypothesised that alcohol cue exposure would magnify attentional bias for alcohol-related stimuli on the Stroop task.

There have been few prior studies of alcohol attentional bias in non-dependent drinkers (see Jones and Schulze, 2000). One such study (Cox *et al*., 1999) found that alcohol-related visual cues presented prior to the Stroop task significantly slowed reaction times on the task, but only among heavy drinkers. Additionally, the degree of cue reactivity in the non-dependent drinkers varied directly with the amount of alcohol that they habitually consumed. In the present study, we tested non-dependent drinkers who represented a range of patterns of alcohol use. We hypothesized that: (1) heavy drinkers would show greater attentional bias for alcohol stimuli than light drinkers; (2) the attentional distraction would be magnified by alcohol cue exposure. Finally, we expected an interaction between level of drinking and cue exposure, such that heavy drinkers who were exposed to alcohol cues would show the greatest attentional bias of all.

SUBJECTS AND METHODS

Participants

Participants were 80 undergraduate psychology students (five males, 75 females) attending the University of Wales, Bangor, who received course credit for participating. The recruitment advertisement specified that participants should not be colour-blind and that they should abstain from alcohol for ≥6 h prior to the experiment.

Cue exposure stimuli

For the cue exposure prior to the experimental task, participants were presented with either an alcoholic or a non-alcoholic beverage. Beer was selected as the alcoholic beverage, because of its high alcohol odour salience (Stormark *et al*., 1995) and common use among university students. ‘Budweiser’ was selected as the brand of beer to use, because it is well-known. The non-alcoholic beverage was a well-known ‘sports’ soft drink called ‘Lucozade’. It was selected because it is: (1) potentially consumable; (2) desirable as a stimulus object; (3) not associated with alcohol (see Newlin *et al*., 1989).

Stroop stimuli

There were three categories of word stimuli, each of which consisted of 10 common brand names intermixed with 10 generic names. The alcohol-beverage category included these brand names: Archers, Carling, Guinness, Hardys, Hooch, Lambrini, Malibu, Miller, Strongbow and Woodys; and these generic names: beer, vodka, shorts, whiskey, bar, alcopops, stout, cocktails, spirits and alcohol. The non-alcoholic beverage brand names were Fanta, Sprite, Ribena, Tizer, Pepsi, Robinsons, Tango, Perrier, Vimto, Schweppes, and the generic names were squash, espresso, juice, tea, coffee, milk, water, cordial, lemonade and milkshake.

Because the alcohol and non-alcohol words were semantically related to each other, an additional category of words was used, which were semantically related to each other but not to the two beverage categories. Using this category allowed beverage relatedness to be separated from alcohol relatedness. The category included cleaning products and other cleaning-related words, with 10 brand names: Flash, Pledge, Domestos, Bleech, Vanish, Comfort, Dettol, Persil, Harpic, Fairy; and 10 generic names: brush, duster, polish, squeegee, shammy, shampoo, sponge, flannel, bucket and hoover. The stimuli comprising the three word categories were matched for word length and number of syllables per word. A fourth category was intended to be entirely neutral and void of meaning. Each stimulus in this category was a sequence of five X’s. Each of the categories of stimuli was presented on a laminated card. On the word cards, each word occurred four times, yielding a total of 80 stimuli. Each word was written in uppercase letters, ~1.5 cm high. There were also 80 stimuli on the card containing the XXXXXs. On both kinds of cards, each stimulus was printed in either red, yellow, blue or green ink, and each colour appeared 20 times. The words and colours were arranged in such a manner that no word or no colour was adjacent to the same word or colour.

Questionnaires

During the cue exposure prior to the Stroop task, participants were asked to evaluate the beverage with which they had been presented, using a series of adjectival ratings. The purpose of the evaluation was to increase the salience of the beverage exposure. The following adjectives were used for the alcoholic cue exposure: Bubbly, Thirst-quenching, Appetising, Bright, Pleasant-smelling, Mouth-watering, Desirable to drink. The same adjectives were used for the non-alcoholic cue exposure, except that ‘Bubbly’ was replaced with ‘Sparkling’. Participants responded to each adjective on a 7-point scale, ranging from ‘Not at all’ to ‘Very much’.

To evaluate their drinking habits, participants were asked to complete the Khavari Alcohol Test (KAT; Khavari and Farber, 1978) post-experimentally. The original KAT includes three broad classes of alcoholic beverages: beer, wine and spirits. The version used in the present study was modified to include additional beverage categories, from which the current sample was likely to drink: cider, stout, whiskey, liquor, cocktails and alcopops. Alcopops is similar to the North American product called ‘Wine Cooler’. For each beverage named on the KAT, respondents were asked to indicate four aspects of their habitual consumption: usual frequency (FU), usual volume (VU), maximum volume per occasion (VM), frequency of maximum volume per occasion (FM) and length of abstinence. A final question (additional to the original KAT) asked respondents to indicate how long it had been since they last drank an alcoholic beverage.

From these responses, various indices of consumption were derived. One commonly used index is the Annual Absolute Alcohol Intake (AAAI), which is calculated from the formula, VA = (FU – FM)(VU) + (FM)(VM). The formula is used separately for each of the beverages, the volume of each beverage consumed is then multiplied by the percentage of absolute alcohol that that beverage contains, and then the products are summed. Thus, the AAAI index adjusts the individual's annual consumption of alcohol to account for occasions on which a greater amount than usual is consumed. The KAT has been demonstrated to be a reliable and valid measurement of alcohol use (Khavari and Farber, 1978; Loethen and Khavari, 1990).

Procedure

Participants were tested individually in a quiet, well-lighted room. Two experimenters were present at each testing session. The respondents were first told the nature of the experiment, including the fact that they would be asked to evaluate a beverage that would be either alcoholic or non-alcoholic. Informed consent was then obtained.

The experiment was conducted in three stages. In the first, the cue-exposure stage, participants were informed that an inverted opaque container on the table in front of them contained a beverage that may or may not be alcoholic. Participants were instructed to remove the covering, open the beverage, pour its contents into the empty glass on the table, smell the beverage while imagining that they were drinking it, but not to taste or drink the beverage. Next, the participants evaluated the beverage by completing the beverage saliency questionnaire. In the second stage, participants completed the emotional Stroop task. In order to familiarize them with the task, they were first asked to name the colours on a practice card. It consisted of a single column of 20 colour-congruent words. That is, the names of four colours (red, yellow, blue, green) were printed in the corresponding colour (e.g. the word 'red' written in red ink). Thereafter, participants were presented with the four Stroop cards, one at a time. Beginning at the top of the left-hand column and proceeding downward, participants were instructed to: (1) name the colours in which the words were printed; (2) ignore the meaning of the words; (3) complete the task as quickly and as accurately as possible; (4) in case they made a mistake, not to try to correct it. The order of presentation of the four cards was counterbalanced across participants.

The experimenter said 'start' and using a stop watch began timing as the participant named the colour of the first word and continued until s/he had named the colour of the last stimulus on the card. After completing two Stroop cards, participants were given 1 min of rest, before completing the last two cards. Finally, in the third stage of the experiment, participants completed the KATest. After doing so, they were debriefed, thanked for their participation, and dismissed. Testing occurred over a 2-week period. Half of the participants were tested during the first week with alcoholic cue exposure. The other half was tested in the second week with non-alcoholic cue exposure.

Statistical analysis

Analysis of the data involved a series of preliminary analyses and a series of major analyses. The purpose of the preliminary analyses was to describe the sample of participants (their pattern of alcohol consumption) and their simple reaction times (prior to calculating interference scores). For the preliminary analyses, analysis of variance was used, followed by *post hoc* Newman–Keuls tests (with Bonferroni correction). The major analyses used regression models. Regression analysis is more sensitive than analysis of variance because it does not suppress finer differences between the independent and dependent variables, allowing each independent variable to be assessed independently of the others. It is particularly useful in cases where large effect sizes are not expected, as in the present study that tested social drinkers rather than alcohol-dependent participants.

RESULTS

The means ± SD of the indices derived from the KAT are shown in Table 1. One-way, repeated-measures analysis of variance indicated a significant effect for type of beverage [$F(3, 237) = 4.62$, $P < 0.004$]. *Post hoc* Newman–Keuls tests indicated that participants drank fewer standard units of alcopops than of beer ($P = 0.04$), wine ($P = 0.03$) or spirits ($P < 0.002$).

On the Stroop task, participants made few errors, averaging one or two errors per card. Because of their infrequency, errors were not considered in the analyses. Inspection of reaction times for the Stroop cards indicated that six participants had scores on the alcohol-related Stroop card that were ≥2 SD above or below the mean of the sample. These six participants were eliminated from the analyses. The mean reaction times of the remaining participants to each of the four categories of stimuli are shown in Table 2. Analysis of variance indicated a highly significant effect for stimulus category [$F(3, 219) = 89.36$, $P < 0.001$]. This effect was caused entirely by participants' faster reactions to the 'XXXXX' stimuli than to the other three categories, which did not differ from each other ($P > 0.10$). Hence, considering the participants as a whole,

Table 1. Khavari Alcohol Test Indices

Index	Values (mean ± SD)
AAAI	529.0 ± 543.4
Alcoholic drinks/week	20.4 ± 20.9
Beer (drinks/week)	5.1 ± 6.7
Wine (drinks/week)	4.3 ± 6.9
Spirits (drinks/week)	8.1 ± 16.0
Alcopops (drinks/week)	2.8 ± 4.7
Days since last drink	5.4 ± 7.5

AAAI, Annual Absolute Alcohol Index (number of ounces of absolute alcohol drunk per year). Because one standard alcohol drink contains one-half ounce of absolute alcohol, the AAAI for the four beverage categories was by divided by 26 to determine the number of standard drinks consumed per week.

Table 2. Total reading times for four categories of Stroop stimuli

Stimulus category	Values (mean ± SD)
Alcoholic beverages	55.8 ± 6.6
Non-alcoholic beverages	56.4 ± 7.3
Cleaning products	56.1 ± 8.3
XXXXXs	47.8 ± 6.8

there was no greater attentional distraction for words related to alcoholic beverages than for those related to either non-alcoholic beverages or to cleaning products.

Next, we tested the hypothesis that attentional bias for the alcoholic beverages was confined to the heaviest drinkers and that, for them, the bias was magnified under alcoholic cue exposure. To establish the most stringent test of alcohol-specific attentional bias, three separate interference scores were calculated by subtracting, from each participant's mean reaction time to the alcohol-beverage words, his or her mean reaction time to: (1) non-alcoholic beverages; (2) cleaning products; (3) XXXXXs. Regression analyses were run for each of the three kinds of interference scores (as described below). The results indicated that the attentional bias for alcohol-related stimuli was significant only when the bias was defined as the degree to which reaction times to alcoholic beverages exceeded reaction times to non-alcoholic beverages. For the other kinds of interference scores, neither the main-effect variables nor their interaction approached statistical significance. Hence, in the results reported below the dependent variable was interference scores defined as the difference between reaction times to the alcohol beverages and reaction times to the non-alcohol beverages.

The regression analyses were conducted to identify which of the independent variables (alcohol consumption, type of cue exposure, and the interaction between these two variables) predicted students' alcohol attentional bias independently of the other predictors. Howell's (1997, p. 541) formula was used to test the significance of increments in R^2 resulting from the successive addition of predictor variables. The results of the first analysis that included all participants indicated that the interaction between amount of alcohol habitually consumed and type of cue exposure (i.e. the product term) was a highly significant predictor of alcohol attentional bias ($\Delta R^2 = 0.093$, $F = 7.22$, df = 1,70, $P < 0.009$). Additional regression analyses were run to identify the source of the significant interaction. Specifically, participants were divided on the basis of their AAAI scores into the upper and lower one-third of the distribution, and the same hierarchical regression that was run on the entire sample was run again on each of the two subgroups. The results showed that for participants who were low consumers of alcohol, neither AAAI, type of cue exposure, nor the interaction between these variables predicted attentional bias for the alcohol-related stimuli ($F < 1.0$ for all three predictor variables). On the other hand, for participants who were high consumers of alcohol, there was again a significant interaction between AAAI and type of cue exposure independently of all of the other variables ($\Delta R^2 = 0.143$, $F = 4.38$, df = 1,19, $P < 0.05$). Bivariate correlations revealed the source of this interaction. For the heavy drinkers who were exposed to the alcoholic beverage prior to the Stroop task, the amount of alcohol that participants habitually drank predicted the degree of alcohol attentional bias ($r = 0.64$, df = 11, $P = 0.02$). For the heavy drinkers who were exposed to the non-alcoholic beverage prior to the Stroop task, the amount of alcohol that participants habitually drank was not significantly related to the degree of alcohol attentional bias ($r = -0.45$, df = 10, $P = 0.17$).

Finally, bivariate correlations indicated that 'days since last drink' (from the KAT) was unrelated to any of the three kinds of alcohol interference scores ($P \geq 0.76$).

DISCUSSION

Following the previously consistent demonstrations of attentional bias for alcohol-related stimuli among dependent drinkers, one purpose of the present study was to determine whether or not this attentional bias also occurs among non-dependent drinkers without a recognized drink problem. The second purpose of the study was to identify the particular circumstances under which alcohol-related attentional bias might and might not occur among non-dependent drinkers. Finally, the study sought to extend our knowledge of the effects of alcohol cue exposure on cognitive processes in non-dependent drinkers.

Participants were university students who represented a range of drinking practices. When the entire sample of participants was considered, results indicated no overall attentional distraction for the alcohol-related words. Cox *et al*. (1999) also did not find attentional bias for alcohol stimuli relative to other categories of semantically related stimuli among a random sample of university student drinkers. The findings of these two studies together suggest that cognitive processes that underlie selective attention for alcohol-related stimuli on the Stroop task are not sufficiently developed in non-dependent drinkers to be generally observed.

Nevertheless, in the present sample, alcohol attentional bias did occur under a circumscribed set of circumstances. Specifically, among participants who were high consumers of alcohol (i.e. those in the upper one-third of the distribution of AAAI scores) and who were also exposed to the alcoholic beverage cues prior to the Stroop task, there was a significant association between the amount of alcohol that was habitually drunk and alcohol-related attentional bias. As the amount of alcohol consumed increased, so did the time taken to respond to the stimuli related to alcoholic beverages relative to non-alcoholic beverages. Similarly, Cox *et al*. (1999) found that alcohol-related visual cues presented prior to the Stroop task significantly slowed reaction times on the Stroop task, but only among heavy drinkers. In the present study, neither heavy drinkers who were exposed to the non-alcoholic cues nor light drinkers (regardless of the kind of cue exposure) showed alcohol-related attentional bias. Taken together, these results suggest that allocating attentional resources disproportionately to alcohol-related stimuli is not restricted to alcohol-dependent drinkers, but also occurs in non-dependent drinkers in certain circumstances.

There are several possible explanations for why response times for the three word categories did not differ among participants as a whole. First, word category was a within-participants variable and, for participants who completed the alcohol Stroop card prior to the other cards, perhaps there was a carry-over effect, such that the alcohol-related content might have continued to have a cognitive influence during presentation of the other cards, causing response times on them to be slowed. Secondly, the alcohol cue exposure (which half of the participants received) may have influenced response times throughout the Stroop task, reducing between-card differences, which might have otherwise occurred. Thirdly, the results are consistent with the possibility that the participants had difficulty inhibiting attention for any semantically or emotionally meaningful stimuli. Fourthly, probably there was some generalization between the alcoholic and non-alcoholic beverage words. That is, both are beverages and are not entirely dissimilar, and people often mix non-alcoholic drinks with alcohol. This fact may have obscured differences between alcohol and non-alcohol words, which might otherwise have occurred.

A further consideration is that the cleaning-related stimuli were probably not entirely neutral. In fact, they share some properties with the beverages, inasmuch as they come in containers, are in liquid form, and people open and pour them in order to use them. In addition, the cleaning words may have been related to participants' current concerns (e.g. Klinger, 1995). For instance, older female participants commented that they found it particularly difficult to ignore the meanings of the cleaning words because they associated these words with domestic tasks, which they often performed. Interference scores involving the non-alcoholic beverages may have provided the best test of alcohol attentional bias because the two categories of stimuli were more semantically related to each other (both are beverages). In future studies, words that are unequivocally neutral could be used, such as those that Waters and Feyerabend (2000) devised. Future research should also ask participants to ascertain their familiarity with specific words and whether or not they are emotionally salient for them.

The present study extends our knowledge about the effects of different kinds of alcohol cues on the cognitive processes in non-dependent drinkers. Unlike the Cox *et al*. (1999) study that used alcohol-related visual stimuli, the present study used *in vivo* beverage exposure. However, unlike Jones and Schulze (2000), who required participants to sip an alcoholic drink, the present study did not allow participants to drink any alcohol during the experiment. To create still stronger cue exposure, it would be desirable for future studies to have participants specify their favourite alcoholic beverage and then allow them to actually taste (or drink) that beverage, rather than just inspecting and rating it.

In conclusion, the present experiment adds to the accumulating evidence (Sayette *et al*., 1994; Cox *et al*., 1999) that alcohol cues can affect automatic cognitive processes in non-dependent drinkers, as well as in alcohol-dependent drinkers. The present results are also consistent with Tiffany's (1990) cognitive processing model of drug use and Cox and Klinger's (1988, 1990) motivational model, which hold that automatic cognitive processes that maintain addictive behaviours develop gradually during the course of an individual's substance use, from initial experimentation to dependence.

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