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Attentional re-training decreases attentional bias in heavy drinkers without generalization

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ABSTRACT

Aims   To examine whether alcohol-related attentional bias (AB) can be reduced by training heavy drinkers to attend to soft drinks as an alternative to alcohol. Diminishing AB is important because AB has been suggested to be a significant factor in the development, maintenance and relapse of addictive behaviours. AB was trained in a clinically relevant design, and we studied the generalization of this training. **Design, participants and intervention**   We assigned randomly 106 heavy drinking male college and university students to the attentional re-training (AR; modified visual-probe task) or control condition (standard visual-probe task). **Setting**   Laboratory at Maastricht University. **Measurements**   We measured the effects of AR on the visual-probe task with stimuli that were presented in the AR and with new stimuli, and on an alternative measure of AB, the flicker paradigm. We further measured effects on craving and preference for either an alcohol beverage or a soft drink. **Findings**   After AR, participants had learned to avoid alcohol stimuli and had developed an AB for soft drinks. This effect was restricted to stimuli used in the AR. The flicker task, where AB for alcohol was found in both the AR and control groups, was not affected by the AR. No effect was found on craving and the preference task. **Conclusions**   Although heavy drinkers can learn to attend selectively to an alternative category for alcohol, a single AR is not sufficient to decrease symptoms of problem drinking.

Keywords   Alcohol, attentional bias, attentional re-training, flicker paradigm, visual-probe.

INTRODUCTION

It has been hypothesized that attentional bias (AB) for alcohol- or drug-related stimuli elicits craving and drug seeking behaviour [1,2], leading to the development, maintenance and relapse of addictive behaviours [2–4]. Attention prioritizes detection, selection and monitoring of certain stimuli over others and as such has been proposed to mediate cognition, emotion and behaviour [5]. AB is a particular readiness to process certain stimuli rather than others, triggered by the incentive value of appetitive stimuli [6,7]. This process instigates corresponding cognitions [8] that cause attention either to maintain the selected stimulus or to avoid it [9]. Avoidance from alcohol stimuli has been found in in-patient alcoholics [10], probably because they are aware of negative consequences and have negative implicit associations with alcohol [11].

The aims of the present study are to test a training method to reduce attentional bias (attentional re-training, or AR) in heavy drinkers and to measure the subsequent effects on craving and behaviour. Our re-training is based on a standard AB measure, the visual-probe task. Two other AB measures often used in alcohol research are the flicker paradigm for induced change blindness and the addiction-Stroop task. Results of the addiction-Stroop task, however, are difficult to interpret [3]. We have selected the visual-probe and flicker paradigm as dependent measures in this study. In the visual-probe task, two stimuli representing two categories (e.g. alcohol and neutral) are presented simultaneously on a computer monitor. After a short interval the stimuli disappear, and a probe consisting of one or two pixels replaces one of the stimuli. Participants differentiate as quickly as possible between the probes by pushing one of two buttons. Faster responses to probes replacing alcohol stimuli indicate AB towards alcohol relative to

neutral stimuli. AB in heavy drinkers has been found with stimulus presentations of 500 ms [12,13] and 2000 ms [13]. In the flicker paradigm, a display with alcohol-related and neutral objects is presented for 250 ms on a computer screen. A mask is then presented for 80 ms, followed by the display with one object changed and again the mask. This sequence is repeated until participants detect the change. Jones *et al.* [14] found that heavy, but not light, drinkers detected alcohol-related changes faster than neutral changes.

AB has been found to correlate with craving for alcohol [2,15]. Until recently, however, the causal direction of this relationship had not been demonstrated experimentally. The best way to test whether AB causes craving is to manipulate AB and examine the effect on craving (see Mathews & Macleod [16]). Note, however, that this leaves open the possibility that the relationship is bidirectional [2]. Recently, researchers investigated the possibility that heavy drinkers' AB can be manipulated by using modified AB measures [17]. The idea stems from MacLeod *et al.*'s pioneering work in anxiety research [16,18]. They demonstrated a causal effect of AB for negative stimuli on emotional vulnerability. In their 'attention training', participants were subjected to a modified visual-probe task with threatening and neutral words. In a standard visual-probe task, probes are distributed on a 50/50 basis over both categories over multiple trials. In the training version, however, probes mostly replaced threatening words for the 'attend-negative' group and neutral words for the 'attend-neutral' group. Results showed that during the training, the 'attend-negative' group had learned to attend selectively to threatening stimuli and showed more negative reactions to a subsequent stress task than the attend-neutral group.

Field & Eastwood [19] demonstrated that AB for alcohol has a causal effect on craving and drinking behaviour. They used a modified visual-probe task [18] to train half of their heavy drinking participants to attend to alcohol pictures and the other half to avoid alcohol pictures (AR). Participants in the attend-alcohol condition demonstrated increased AB from pre- to post-attention-training, and these participants reported more craving (measured on a one-item scale) and drank more beer in a post-training taste test than participants in the attend neutral group. With this design, however, it is not possible to determine whether differences in craving and drinking behaviour are caused by an increase in one group, a decrease in the other group, or both. The same accounts for the depression measures in MacLeod *et al.*'s study [18]. Our study has been designed to overcome this problem by using a control group that was not trained, but performed a prolonged version of the standard visual-probe task.

In anxiety research, reductions in symptoms of psychopathology have been reported after multiple AR sessions to diminish AB [20,21]. The purpose of the present study was to test the possibilities and impact of AR on addictive behaviours. It is the first study to test experimentally a clinically relevant AR in addiction in a large sample of problem drinkers. Our design differs from Field & Eastwood's in two aspects. First, we tried to assess AR-effects by comparing participants who were trained to avoid alcohol pictures with a control group that performed a prolonged visual-probe task instead; in this way, we could determine the effectiveness of treatment compared to no-treatment. Secondly, instead of neutral pictures we trained participants towards soft drinks, a relevant alternative for alcohol [22–24].

Rather than learning to avoid the specific stimuli used in the AR, problem drinkers should eventually learn to avoid alcohol in general. Therefore, our post-AR-test visual-probe measured not only effects with stimuli from the AR, but also with new stimuli. In anxiety research, effects on new stimuli have been found [18,25], but in alcohol research generalization has not yet been explored. A second unattended generalization issue we address is whether the AR-effect generalizes to an alternative AB measure, the flicker paradigm [14]. AB measures, however, correlate poorly [26,27] and therefore their results might not necessarily correspond. We also investigated the effects of AR on craving and preference for an alcoholic or a soft drink.

In summary, our first hypothesis was that AR would result in a diminished AB for alcohol in the AR group, compared with the control group. Secondly, we explored whether this difference would be found for new stimuli. Thirdly, we explored whether we could measure a corresponding difference with the flicker paradigm. Fourthly, we hypothesized that, after AR, participants would choose a soft drink more readily than an alcohol beverage, compared with the controls. Fifthly, we hypothesized that the AR group would crave less for alcohol than the control group after AR.

METHOD

Participants

Participants were 106 male undergraduate students from Maastricht University and a nearby vocational college. They were selected for drinking heavily (> 20 Dutch standard drinking units of 10 g of alcohol per week), measured with a self-report questionnaire [28] based on the time-line follow-back procedure [29]. We also selected them on having had at least one binge-drinking episode in the last 2 weeks prior to selection. Mean age was 21.4 years (SD = 2.0). On the Rutgers Alcohol Problems Index [30,31] participants scored 19.35 (range: 3–36), an average item score of 1.07; 72%

Figure 1 Example of a matched picture pair (left alcohol, right soft drink) as used in the visual-probe task

scored above the average of clinical samples, 0.80 [30]. Using the Alcohol Use Identification Test [32], participants scored 14.40 on average (range 7–25); 91% scored above 10, the cut-off score for alcohol problems [32]; 98% scored above eight, indicating hazardous drinking [33]. Participants were assigned randomly to either the AR or control condition (*n* = 53 per condition). On average, AR participants drank 40 standard Dutch units per week (range 21–94), as did control participants (range 21–87). Groups did not differ on age, alcohol use and alcohol problems (all *P*s > 0.70).

Materials

We used 30 alcohol-related pictures for the AR and pre- and post-test visual-probe. Each of these pictures was paired with a soft drink picture, matched by colour, height, width and shape (Fig. 1), following Jones *et al.* [34]. Some of these pairs were used in pre-test, AR and post-test, some in AR only, and some in the post-test only. Height was standardized to 9 cm. We used another 11 alcohol-related pictures for the flicker paradigm and matched those with 11 soft drink pictures. Both tasks were programmed in ERTS 3.18 [35].

Procedure

Participants were recruited by e-mail briefings and posters and flyers in university buildings and fraternities. In a telephone interview, we screened their drinking behaviour. On the test day, prior to inclusion in the study, they gave informed consent. They were then tested in separate cubicles containing a computer.

First, participants were primed with a sip of beer (all participants were regular beer drinkers), because this may increase the chance of finding AB in heavy drinkers [36–38]. They then rated their craving for alcohol and performed the pre-test visual-probe. Subsequently, AR started for the experimental group and a prolonged

standard visual-probe task for the control group, followed by the post-test visual-probe and the flicker task. Finally, all participants could choose a free alcohol or soft drink (preference task), after which we measured successively craving for alcohol and problem drinking. At the very end, participants were asked about their ideas concerning the purpose of the study (awareness check). After all participants were tested, they were debriefed by e-mail about the real purpose of the study. They received 11 euros for participating.

Visual-probe and AR

The visual-probe task consisted of three consecutive phases: a pre-test, the AR or control phase and a post-test. In all phases, trials consisted of a picture representing alcohol and one representing soft drinks. The tests were identical for both groups. They consisted of 48 trials, with a 50/50 distribution of probes over the two categories: probes replaced both alcohol and soft drinks in 24 trials. The pre-test consisted of 12 different picture pairs, which were repeated four times. The post-test presented six 'old' picture pairs that were used in the AR phase and six 'new' picture pairs that had not been used previously.

The AR phase consisted of 624 trials, following MacLeod *et al.* [18]. Probes replaced soft drinks in 600 trials and alcohol in 24 trials. Two sets of picture pairs were used, each with a different probe distribution, together constituting a 96/4 distribution. The first set was used for 576 critical trials with a 100/0 (soft drinks/alcohol) probe distribution. This set consisted of 24 different picture pairs, each repeated 24 times; half of these 24 picture pairs had been used in the pre-test and half were new. The second set was used for 48 filler trials with a probe distribution of 50/50. This set consisted of 12 different picture pairs (six from the first set and six new pairs), each repeated four times. The filler trials were spread randomly throughout the AR phase. The control phase differed from the AR phase only in the probe distribution: control participants were presented with the same picture pairs as often as the AR participants; only the probe distribution was 50/50 in all 624 trials.

Pictures were presented on a grey background on a computer screen, with an average distance of 6 cm between their inner angles. Trials began with a fixation cross in the middle of the screen. A picture pair was then presented for 500 ms and replaced by a probe that randomly, with a 50% probability, consisted of one or two white pixels. Participants were to respond as quickly as possible: pushing one button if the probe consisted of one pixel and another button for two pixels. Feedback was given in the case of a response that was too slow (over 3000 ms), too fast (less than 150 ms) or wrong (wrong

button). After a correct response, the screen was cleared for 500 ms after which the next trial started. Participants were seated approximately 60 cm from the screen.

Flicker paradigm

Participants performed four flicker trials, each consisting of the presentation of a 3×6 matrix of alcohol and soft drink pictures with nine alcohol pictures on one side (3×3) and nine soft drink pictures on the other side (3×3). Matched alcohol–soft drink pairs were placed on the opposite side of the matrix, mirrored against the vertical middle line. Trials started with 250 ms presentation of the original matrix, followed by 80 ms presentation of a mask. Then 250 ms presentation of the matrix with one picture being replaced by another, followed by 80 ms presentation of the mask. This loop was repeated until the participant noticed the change and pressed a button corresponding to the side of the change, left or right. The dependent variable was response latency. In random order, each participant was given two alcohol and two soft drink changes. Changes were in the middle line of the 6×3 matrix, each on a different position. For every individual, alcohol and soft drinks were presented on the same side of the screen in all trials, sides being balanced within groups.

Preference task

Preference for alcohol or soft drinks was measured by offering participants a choice between four different, well-known drinks (see Karpinski & Hilton [39]). Participants were presented individually with a serving tray containing two cans of beer and two cans of soft drink, colour-matched. They could choose one can to take home with them.

Craving for alcohol

Participants indicated their urge to drink alcohol 'right now' on a single analogue scale [40] of 100 mm, ranging from 'no urge at all' to 'an almost irresistible urge'.

RESULTS

Visual-probe task

Following MacLeod *et al.* [18], we calculated median discrimination latencies to minimize the effect of outliers. Latencies under 200 ms and over 2000 ms were excluded from the analyses; data from error trials were also excluded (totalling 3.6% of data in the pre-test, 4.8% in the post-test). We calculated AB scores by subtracting latencies on congruent trials (alcohol) from latencies on incongruent trials (soft drinks), a positive score indicating AB for alcohol and a negative score AB for soft drinks (Table 1).

Table 1 Averaged median response latencies and AB score in visual-probe task for AR group and control group.

	AR (n = 53)		Control (n = 53)	
	Median	*SD*	*Median*	*SD*
Pre-test				
Alcohol	641.09	98.00	652.59	86.12
Soft drinks	646.68	80.61	648.43	96.17
AB	5.59	69.11	−4.15	48.39
Post-test				
Alcohol	578.01	58.76	569.27	64.18
Soft drinks	564.70	59.50	577.18	67.49
AB	−13.32	51.34	7.91	39.86
Alcohol old	582.84	75.43	567.09	78.65
Soft drinks old	560.55	67.52	574.54	66.81
AB old	−22.29	75.68	7.45	70.12
Alcohol new	577.64	64.81	571.24	67.09
Soft drinks new	569.16	72.12	571.39	77.13
AB new	−8.48	66.53	0.15	73.77

AB = attentional bias; AR = attentional re-training; median = averaged median scores per group (in ms); SD = standard deviation from averaged median scores.

Our main hypothesis was confirmed by a 2×2 mixed design analysis of variance (ANOVA), with condition (AR/control) as the between-subjects factor and time (pre-test/post-test visual-probe) as the within-subjects factor. The ANOVA revealed a significant interaction effect in the predicted direction: $F_{(1,104)} = 4.73$, $P < 0.05$. Independent-samples *t*-tests indicated that groups did not differ on AB scores on the pre-test, $t_{(104)} = 0.84$, $P = 0.40$. However, in the post-test AR participants had a significantly smaller AB score than control participants, $t_{(104)} = -2.38$, $P < 0.05$, indicating that AR had been effective in diminishing attention for alcohol relative to soft drinks.

To explore whether the AR-effect had generalized to new pictures, we compared AB scores on new pictures between the groups. An independent-samples *t*-test revealed no significant difference: $t_{(104)} = -0.63$, $P = 0.53$; AR had not significantly changed AB measured with new pictures.

Flicker paradigm

One outlier with a mean AB score of more than two standard deviations from the group mean was excluded from analyses. Data from one participant were lost because of technical problems. Both were control participants. We calculated the flicker scores by averaging latencies for each category. To explore whether the AR-effect had generalized to the flicker paradigm, we performed a 2×2 ANOVA with condition (AR/control) and stimulus type (alcohol/soft drinks) as independent variables. The

Table 2 Craving for alcohol for AR group and control group.

	AR		Control	
	M	SD	M	SD
Before AR	38.08	22.70	32.85	26.41
After AR	42.15	25.30	35.36	27.05

Scores are measured on a single analogue scale, possible range of scores 0 mm (no urge at all) to 100 mm (an almost irresistible urge). AR = attentional re-training; M = mean; SD = standard deviation.

interaction was non-significant, $F_{(1,102)} = 0.27$, $P = 0.60$, indicating no generalization. We found no correlation between the flicker and the post visual-probe task ($R = -0.10$, $P = 0.31$), possibly explaining this finding. The main effect for stimulus type in the ANOVA was significant, $F_{(1,102)} = 5.03$, $P < 0.05$, showing a shorter overall alcohol latency (M = 4802 ms, SD = 3385 ms) than soft drinks latency (M = 5812 ms, SD = 3733 ms), indicating AB for alcohol irrespective of group.

Preference task

One participant in the AR group refused a can. Of the remaining 52 participants in the AR group, 34 (65%) chose an alcoholic beverage, compared with 29 of 53 (55%) in the control group. A χ^2 test revealed no significant difference, $\chi^2_{(1)} = 1.25$, $P = 0.27$.

Craving for alcohol

To test whether the AR would decrease the urge to drink alcohol, we performed a mixed 2×2 ANOVA with group (AR/control) as the between-subjects factor and time (urge before AR/after AR) as the within-subjects factor (Table 2). No significant interaction was found, $F_{(1,104)} = 0.22$, $P = 0.64$; AR had not affected craving.

Awareness check

Six participants in the AR condition and eight in the control condition recognized that the focus of attention was measured with the visual-probe task. Analyses of visual-probe scores were repeated without these participants, but results did not change. None of the participants recognized correctly the purpose of the AR.

DISCUSSION

AR was successful in decreasing attention for alcohol stimuli relative to the alternative category, soft drinks. This conclusion should, however, be qualified: the change in AB was not significant for pictures that were not used in the AR. Further, the AR and control group did not score differently on the flicker paradigm, suggesting lack of generalization outside the task that was used to re-train. Additionally, AR did not decrease craving and preference for alcohol.

Although AB scores on new pictures were smaller for the re-training group than for the control group, this difference did not reach statistical significance. MacLeod *et al.* [18] found generalization effects to new stimuli. This might be explained by differences in experimental designs; MacLeod *et al.* trained one group towards, and the other away from threatening stimuli, thereby creating a bigger difference between AB scores of both experimental groups than found in our study (see Fig. 2 in Wiers *et al.* [17]); this increases the chance of finding an effect. Such a watershed design contrasts with our clinically relevant design: we trained only one group; the control group was not trained.

Another difference in design that may account for our limited generalization to new stimuli concerns the number of picture pairs in the re-training. In the training by Macleod *et al.* [18], 48 word-pairs were repeated 12 times, while in our AR 12 picture-pairs were repeated 48 times. Hence, MacLeod *et al.* trained more different exemplars of one category. Their large number of stimuli might have better represented a full category. Our specific stimuli might not have been sufficient to represent a full category. Thus, to find a stronger generalization effect, it could be useful to use more different stimuli in the re-training.

Furthermore, instead of words, pictures are often used as stimuli in AB tasks, because they are more naturalistic and ecologically valid [1]. At the same time, this renders them more specific. This specificity weakens the relation between the AB task and craving and drinking behaviour if pictures are chosen that do not represent drinks that participants normally drink. In this sense, personalizing the stimuli could be a useful option [41].

Alternatively, incongruent findings regarding effects of AR may depend on different mechanisms underlying AB in different domains, addiction and anxiety. In addicted and anxious individuals, attention is directed towards appetitive and threatening stimuli, respectively. Anxiety AB has been theorized to be caused by a vigilance–avoidance pattern to reduce subjective discomfort [42], while AB towards drug stimuli has been hypothesized to result from maintenance of attention or a disengagement problem ([10], but see [13]). It is thought that different neural systems may underlie AB in the different domains [15]. Therefore, it is necessary to be cautious with generalizations concerning the mechanisms of AR and AB across domains. In fact, one has to consider the possibility that AR in addiction might not work as well as in anxiety, or that it may work more effectively using another task [17].

The results of the present study replicated and extended Field & Eastwood's findings regarding AR in alcohol abuse [19]. Both studies found a change in their measure of AB (visual-probe task). Additionally, we found that this effect showed no significant generalization to new stimuli within the visual-probe task, which was not investigated by Field & Eastwood. Another extension in our study was the measurement of the AR-effect with an alternative AB task. Two possible reasons may account for the finding that the AR-effect did not generalize to the flicker paradigm. The first is that the pictures in the flicker paradigm were different from those used in the AR. Because the effect with new pictures in the visual-probe was limited, it might be expected to be even smaller in another task. The second reason concerns poor correspondence between the two AB measures. We found no significant correlation between the flicker paradigm and post-test visual-probe, due perhaps to the low reliability of the tasks [43,44]. A critical difference between the measures could be the response target. In the visual-probe task participants respond to a probe, whereas in the flicker paradigm participants respond to a stimulus.

Field & Eastwood [19] found an increase in craving after participants were trained to attend to alcohol pictures, demonstrating a causal effect of AB on craving. We did not find support for this causality, as the decrease in AB did not diminish craving. This finding is consistent with results for the avoid alcohol group in Field & Eastwood's study; craving for participants who had learned to avoid alcohol did not decrease after a decrease in AB. However, in our study, the AR-effect on craving might have disappeared because of exposure to alcohol cues in the preference task.

We address some limitations to our study to help improve future investigations of AR. First, we trained participants only once. In the paper by Wiers *et al.* [17], Fadardi & Cox describe that they have re-trained participants' AB for alcohol and measured a decrease in drinking after multiple AR sessions (using a modified Stroop task as AR). Additionally, descriptions of studies on reducing AB as a treatment for psychopathologies (general anxiety disorder; social phobia) report effects on other measures (apart from AB itself) only after multiple sessions [20,21]. Studies that did find a strong effect after one session aimed at increasing AB [18,19]; decreasing AB to reduce psychopathology seems to require more effort. Secondly, we recommend using 'old' pictures in the alternative AB task as well. That way, one can differentiate generalization to the alternative task from generalization to new stimuli. Thirdly, we measured behaviour indirectly with a preference task. We did not measure drinking behaviour directly with, for example, a taste-test, because our primary interest was in the generalizability of AR. Finally, we have included only males in our study. Possibly, women react differently to AR.

In summary, the main purposes of this study were to explore possibilities of AR as a clinical tool and to test AR for its generalization properties. To our knowledge, this is the first study in which a clinically designed visual-probe re-training has been tested experimentally in a large sample of problem drinkers. We found that it is possible to train problem drinkers to attend selectively to an alternative category for alcohol. However, this effect was significant only for specific stimuli that were presented in the re-training and did not impact behaviour. Thus, the single re-training did not reveal clinically relevant effects. We believe that multiple AR sessions with more different (new) stimuli should be applied to test whether AR is capable of reducing craving and subsequent drinking behaviour in a clinically relevant way.

Acknowledgements

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