Psicológica (2014), 35, 39-48.

The effect of colour and size on attentional bias to alcohol-related pictures

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Attentional bias plays an important role in the development and maintenance of alcohol addiction, and has often been measured with a visual probe task, where reaction times are compared for probes replacing either a substance-related cue or a neutral cue. Systematic low-level differences between image classes are a potential cause of low internal reliability of the probe task (Ataya et al., 2012). Moreover, it is unclear whether automatic attentional capture by low-level properties such as size and colour in the non-substance related image could reduce attentional bias to the alcohol-related cue. Here, alcohol-related attentional bias was assessed in moderate social drinkers by measuring reaction times to targets that replaced either an alcohol-related or a non-alcohol related (i.e., neutral) picture. All alcohol-related images were greyscale, and the neutral stimulus could be either greyscale ('control'), in colour ('colour'), or greyscale and 25% larger in size ('25% larger size'). We found attentional bias towards the alcohol-related stimuli in the control and 25% larger size conditions, but not in the colour condition. The magnitude of attentional bias was significantly reduced in the colour condition compared to the control and 25% larger size conditions. These findings indicate that salient low-level features in the non-substance related cue, in particular colour, can reduce the effect of alcohol-related content on the allocation of alcohol drinkers' attention. Further, the results highlight the need for image pairs in visual probe tasks to be closely matched on basic perceptual dimensions.

Changes in selective attention to substance-related cues are thought to be causal factors in the development and maintenance of addictive behaviours (for reviews see Field & Cox, 2008; Robbins & Ehrman, 2004). Substance-related cues acquire heightened salience for substance users, and it has been shown that smokers display preferential attention to smoking-related cues (Ehrman et al., 2002), drinkers to alcohol-related cues (Field,

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Mogg, Zetteler, & Bradley, 2004), and heroin users to heroin cues (Bearre, Sturt, Bruce, & Jones, 2007).

A commonly used test to infer biases of attention towards substance-related stimuli is the visual probe task. In a common version of this task, two stimuli (one substance-related and one neutral) are presented simultaneously on the screen for a brief period (typically between 50 to 1000 ms). Immediately following offset of the image pair, a visual target (an arrow or dot) appears at the former location of either the substance-related or neutral cue. Attentional bias towards the substance-related stimuli is inferred from faster reactions to targets at the location of the substance-related stimulus compared to the neutral stimulus. Using this method, attentional bias has been observed for drug users (Field, Mogg, & Bradley, 2004; Constantinou et al., 2010), cigarette smokers (Ehrman et al., 2002) and alcohol drinkers (Field, Mogg, Zetteler, & Bradley, 2004; Townshend & Duka, 2001; Miller & Fillmore, 2010).

Despite being widely used, recently the internal reliability of the visual probe task to assess substance-related attentional bias has been questioned (Ataya et al., 2012). The choice of stimuli in the probe task is a potential cause of the poor reliability of the probe task (Field & Christiansen, 2012), since parameters such as image complexity are known to modulate attentional bias (Miller & Fillmore, 2010). The alcohol-related images in a probe task (e.g., can of beer against a white background) necessarily differ from the neutral images (e.g., glass of water against a multicoloured background) along a number of low-level dimensions, which could potentially confound the findings by introducing biases unrelated to the higher level (i.e., substance-related) processes under investigation. Low-level stimulus dimensions such as image size and colourfulness are well-known to automatically attract attention (Egeth & Yantis, 1997), as demonstrated for instance by the pop-out effect of a colour object in a cluttered visual scene (e.g., Baldassi & Burr, 2004), the capture of attention by a colour singleton (Turatto & Galfano, 2001), or by an object of larger size (Proulx & Egeth, 2008) during visual search. Differences in colour and size between the substance-related and neutral image could therefore either a) mask attentional bias towards the alcohol-related image (i.e., if the salient low-level feature is in the neutral image), or b) cause faster reaction times towards targets replacing the alcohol-related cue (i.e., if the salient low-level feature is in the substance-related image), independently of the alcohol-related content. Thus, we wanted to empirically test whether salient low-level features in the neutral cue would mask attentional bias to the alcohol-related cue.

Recent research has demonstrated that cognitive mechanisms such as self-control can modulate attentional bias towards alcohol-related images (Teunissen, Spijkerman, Vohs, Schoenmakers, & Engels, 2012). Moreover, it has been shown that attentional bias modification training (i.e., training to direct attention away from an alcohol-related cue) can decrease attentional bias in alcohol-dependent patients, potentially leading to clinically relevant outcomes (Schoenmakers et al., 2010). However, it remains unclear whether attention can be biased away from alcohol-related cues by exogenous attentional processes. Orienting attention away from alcohol-related cues could potentially be driven by salient low-level features that automatically capture attention in a proximate non-alcohol related cue, thus overriding attentional bias towards the alcohol-related cue. Given that attentional bias is known to be involved in the maintenance of addiction (for review, see Field & Cox, 2008), it is important to investigate whether attentional bias towards alcohol-related cues could be attenuated by manipulating low-level features of the pictorial images. In the current study we aimed to test whether attentional bias towards the substance-related cue would be attenuated by low-level salient features in the non-substance related images, therefore we manipulated the size and colour of the non-alcohol related cue in a visual probe task using a sample of moderate social drinkers.

METHOD

Participants. 24 participants took part in the study. Recruitment targeted adults who drank alcohol regularly (at least five standard drinks per week) but not above government guidelines (to exclude alcohol dependents). To be included in the study participants were required to be moderate social drinkers, defined as reporting average weekly consumption of greater than ten units of alcohol (ten units per week or less is defined as light drinking by Field, Mogg, Zetteler, and Bradley (2004)), but less than 25 units per week (25 or more is defined as heavy social drinking by Townshend and Duka (2001)) as it has been found that non-drinkers and very light occasional drinkers do not exhibit attentional bias to alcohol cues (Field, Mogg, Zetteler, Bradley, 2004; Townshend & Duka, 2001). Data from three participants was excluded from analysis for reporting average weekly alcohol use outside the inclusion criteria (two participants reported drinking more than 25 units per week, and one reported drinking less than 10 units per week). Of the remaining 21 participants, 12 were female, and mean age was 23.8 (*SD* = 4.2). The study was approved by the Liverpool Hope University Ethics Committee.

Stimuli and apparatus. Visual stimuli were created from 14 image pairs, each pair consisting of a colour photograph of an alcohol-related image, and a colour photograph of a scene closely matched in content but not containing alcohol-related content (‘neutral’ image). These photographs have been used in a previous attentional bias study (Field, Mogg, Zetteler, & Bradley, 2004).

The image size was 331 x 239 pixels (approximately 94 x 67 mm). The colour and size of the original photographs was manipulated to create three experimental conditions. Greyscale versions of the original photographs (both alcohol-related and neutral) were created in Paint Shop Pro Version X2 using the ‘Greyscale’ procedure, which retains the luminance levels of the original colour images. Larger versions of the neutral photographs were also created, where the size was increased by 25% (to 413 x 298 pixels, approximately 117 x 84 mm). One of the image pairs is shown in Figure 1 as an example. An additional 8 pictures (unrelated to alcohol) were used for the practice block.

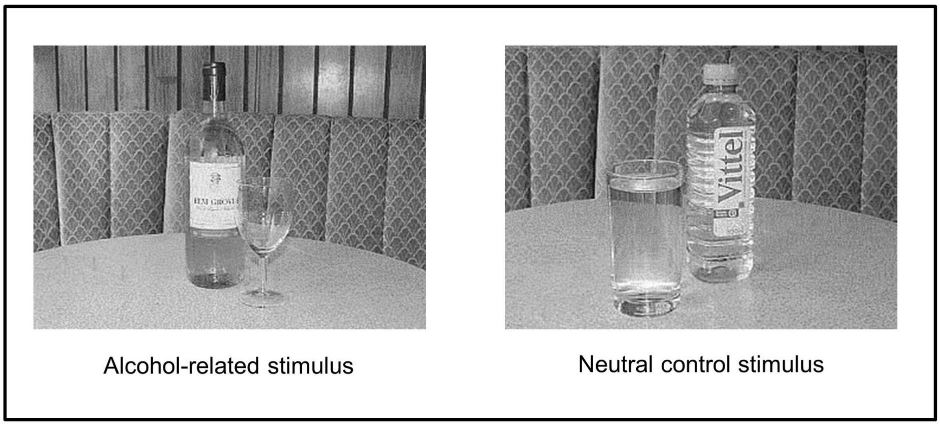

Figure 1. An example of one of the fourteen image pairs, consisting of a greyscale alcohol-related image (left) and a greyscale non-alcohol related control image (right).

Fourier power statistics were computed for each image using the MATLAB Image Processing Toolbox (The MathWorks, Natick, MA) to analyse variations in contrast across spatial scales for alcohol-related and neutral images. For each greyscale image, a two-parameter Fourier statistic was derived by calculating the intercept and slope of a line fitted to its power spectrum (for full details of the procedure, see Groen et al., 2012); these two parameters represent a 'spectral signature' of the images (Oliva & Torralba, 2001). Comparison of the parameters for the alcohol-related and neutral images revealed no significant difference in contrast between the image classes (intercept parameter: $t(13) = .007$, $p = .996$; slope parameter: $t(13) = 1.241$, $p = .236$). Mean luminance was computed for each image and did not differ between alcohol-related and neutral images, $t(13) = .198$, $p = .846$.

Procedure and data analysis. Participants completed a practice block of 8 trials before the main experiment which consisted of two blocks of 84 trials. Each trial began with the appearance of a central fixation cross for 500 ms, followed by a pair of pictures (centers 80 mm to the left and right of fixation) for 500 ms. All picture pairs contained one greyscale alcohol-related image and a neutral (i.e., non-alcohol related) picture which was either 1) a greyscale neutral image of the same size ('control' condition), or 2) a greyscale neutral image 25% larger in size ('25% larger size' condition), or 3) a neutral image of the same size as the alcohol-related picture, but in colour ('colour' condition). Each of the three conditions was repeated 56 times during the experiment, in random order. The alcohol-related picture could appear either on the left or on the right side ($p = .5$). A visual target (a small circle) appeared on the screen in the location of the center of one of the preceding pictures, immediately following offset of the picture pair. In each of the three conditions, the target appeared in the location of the alcohol-related picture in half of the trials (28 trials per condition), and in the location of the non-alcohol related picture in the remaining trials. Participants were instructed to press the 'Z' or 'M' keys on the keyboard if the target was on the left or the right side, respectively. After a response (or after 2000 ms in the case of no response), there followed a blank screen for 500 ms. The experiment was controlled using E-Prime 2.

After the visual probe task, participants completed a questionnaire about drinking habits to obtain information about self-reported average units of alcohol consumed per week over the previous month.

RESULTS

Participants consumed on average 16.0 units of alcohol per week ($SD = 4.4$). Only trials with correct responses were included in the analysis

(<2% of trials were rejected). Of the remaining trials, responses less than 200 ms were excluded (<1% of trials) from further analysis, to exclude anticipatory responses.

Mean reaction times to the targets for each picture condition (control, 25% larger size, colour) are shown in Figure 2A. A repeated-measures ANOVA with factors image type (alcohol vs. neutral) and neutral image condition (control, 25% larger size, colour) found a significant interaction between image type and neutral image condition, $F(1,29) = 5.431$, $p = .016$. Paired t-tests were carried out to explore the interaction effect by comparing reaction times for targets replacing the alcohol-related picture with response times for targets replacing the neutral pictures, separately for each image condition. In the control condition, we found significantly faster reaction times for targets replacing alcohol-related compared to neutral control images, $t(20) = 2.677$, $p = .014$ (Alcohol-related images: $M = 468.7$ ms, $SD = 83.4$; Neutral control: $M = 489.3$ ms, $SD = 99.2$). In the 25% larger size condition, we observed significantly faster reaction times for targets replacing alcohol-related compared to neutral 25% larger images, $t(20) = 2.408$, $p = .026$ (Alcohol-related images: $M = 469.3$, $SD = 86.9$; Neutral 25% larger size: $M = 488.4$ ms, $SD = 91.7$), indicating attentional bias towards the alcohol-related pictures. For greyscale alcohol-related pictures (M = 482.2, SD = 89.3) paired with colour pictures unrelated to alcohol ($M = 471.0$ ms, $SD = 93.1$), no attentional bias effect was observed ($t < 1.6$).

To compare the amount of attentional bias for the control, 25% larger size, and colour conditions, a bias score was calculated by subtracting the RT for the alcohol picture from the RT for the neutral picture, such that a positive bias score indicated attentional bias towards the alcohol-related picture (Figure 2B). A one-way repeated-measures ANOVA comparing the control, 25% larger size, and colour bias scores was significant, $F(1,29) = 5.431$, $p = .016$. Paired t-tests showed significant differences between bias scores for control ($M = 20.6$ ms, $SD = 35.3$) versus colour ($M = -11.2$ ms, $SD = 33.5$) condition, $t(20) = 2.564$, $p = .019$, and for 25% larger size ($M = 19.1$ ms, $SD = 36.3$) versus colour ($M = -11.2$ ms, $SD = 33.5$), $t(20) = 2.441$, $p = .024$.

DISCUSSION

The aim of the study was to investigate whether low-level stimulus properties (image colour and size) could reduce alcohol-related attentional bias in a visual probe task. In a sample of moderate social drinkers, we found a significant alcohol-related attentional bias effect (faster reaction times when targets replaced the alcohol-related cue compared to the neutral cue) for black-and-white alcohol-related pictures when the neutral image was also black-and-white. An alcohol-related attentional bias effect was also present when the neutral picture was greyscale but 25 % larger in size than the alcohol-related picture. Importantly, no alcohol-related attentional bias effect was observed when the neutral picture was the same size as the alcohol-related picture, but was presented in colour. Analysis of the magnitude of attentional bias showed reduced alcohol-related attentional bias in the colour condition, compared to both the control condition and the 25% larger size condition.

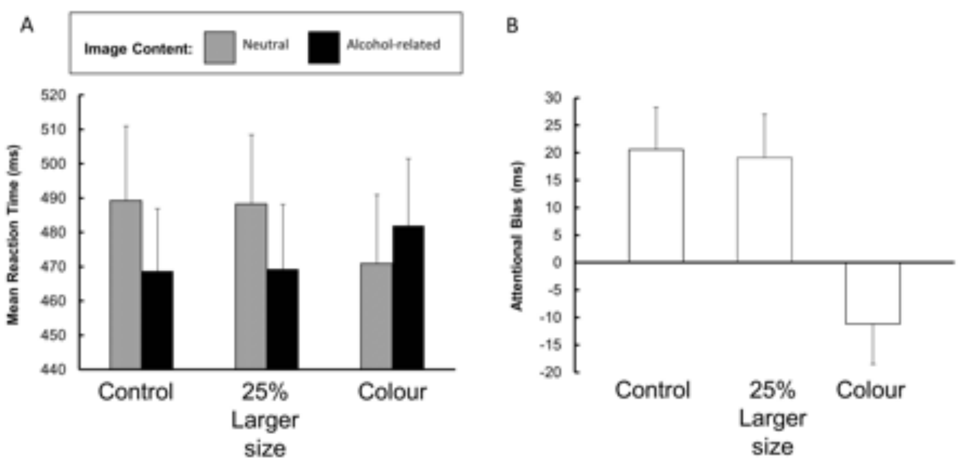

Figure 2. A) Mean reaction time (ms) to targets for neutral (hatched bars) and alcohol-related (solid bars) images, for control, 25% larger size, and colour conditions. Error bars indicate standard error of the mean. B) Mean attentional bias scores for control, 25% larger size, and colour conditions. Positive values indicate attentional bias towards alcohol-related cues.

The finding that reaction times to targets replacing alcohol-related pictures were faster than reaction times to neutral images replicates previous research showing attentional bias to alcohol-related cues (e.g., Field, Mogg, Zetteler, & Bradley, 2004; Townshend & Duka, 2001; Miller & Fillmore, 2010). Crucially, here we go beyond previous findings by showing that alcohol-related attentional bias was unaffected by a change in size of the paired neutral cue (i.e., when the neutral image was 25% larger), but that when the neutral image was in colour, alcohol-related attentional bias was eliminated. This represents a novel finding about the interplay between higher-level substance-related features and low-level stimulus properties on the allocation of attention during a substance-related visual probe task. As such, the current results indicate that certain low-level features (i.e., colour), can attract attention sufficiently to counteract the influence of the higher-level attentional bias towards the substance-related cue. Colour is widely used by advertisers to attract attention towards their products (Meyers-Levy & Peracchio, 1995), so further investigation is warranted into how low-level features of alcohol-related product packaging may modulate substance-related attentional bias. It must be noted, however, that the diminished alcohol-related attentional bias in the colour condition was observed in a sample of social drinkers; further research would need to establish whether a similar attenuation exists in heavier drinkers.

The current findings show that attentional bias to alcohol-related cues can be reduced by salient low-level feature changes in the non-substance related image. The current study used a cue exposure duration of 500 ms, which is thought to reflect a bias in the disengagement of attention from the substance-related cue (Bradley, Field, Mogg, & De Houwer, 2004; Field & Cox, 2008). Future studies could usefully investigate whether colour differences between substance-related and neutral images affects not only the maintenance of attention, but also influences biases in the initial orienting of attention, by using shorter image exposures (e.g., 200 ms or less). Finally, the results emphasise the need to match image pairs in substance-related visual probe tasks as closely as possible on certain low-level features (in particular, colour - for instance by using a uniform background colour in both pictures), to avoid potential low-level confounds when studying the influence of substance-related cues on selective attention.

REFERENCES

Ataya, A.F, Adams, S., Mulling, E., Cooper R.M., Atwood, A.S., & Munafo, M.R. (2011). Internal reliability of measures of substance-related cognitive bias. *Drug and Alcohol Dependence, 121*, 148-151.

Baldassi, S., & Burr, D. (2004). "Pop-out" of targets modulated in luminance or colour: the effect of intrinsic and extrinsic uncertainty. *Vision Research, 44*, 1227-33.

Bearre, L., Sturt, P., Bruce, G., & Jones, B.T. (2007). Heroin-related attentional bias and monthly frequency of heroin use are positively associated in attenders of a harm reduction service. *Addictive Behaviors, 32*, 784-792.

Bradley, B., Field, M., Mogg, K., & De Houwer, J. (2004). Attentional and evaluative biases for smoking cues in nicotine dependence: Component processes of biases in visual orienting. *Behavioural Pharmacology, 15*, 29-36.

Constantinou, N., Morgan, C.J., Battistella, S., O'Ryan, D., Davis, P., & Curran, H.V. (2010). Attentional bias, inhibitory control and acute stress in current and former opiate addicts. *Drug and Alcohol Dependence, 109*, 220-225.

Egeth, H., & Yantis, S. (1997). Visual attention: Control, representation, and time course. *Annual Review of Psychology, 48*, 269-297.

Ehrman, R.N., Robbins, S.J., Bromwell, M.A., Lankford, M.E., Monterosso, J.R., & O'Brien, C.P. (2002). Comparing attentional bias to smoking cues in current smokers, former smokers, and non-smokers using a dot-probe task. *Drug and Alcohol Dependence, 67*, 185-191.

Field, M. & Christiansen, P. (2012). Commentary on Ataya et al. (2011), 'Internal reliability of measures of substance-related cognitive bias'. *Drug and Alcohol Dependence, 124*, 189-190.

Field, M., & Cox, W.M. (2008). Attentional bias in addictive behaviors: A review of its development, causes, and consequences. *Drug and Alcohol Dependence, 97*, 1-20.

Field, M., Mogg, K., Zetteler. J., & Bradley, B.P. (2004). Attentional biases for alcohol cues in heavy and light social drinkers: the roles of initial orienting and maintained attention. *Psychopharmacology, 176*, 88-93.

Field, M., Mogg, K., & Bradley, B.P. (2004). Cognitive bias and drug craving in recreational cannabis users. *Drug and Alcohol Dependence, 74*, 105–111.

Groen I.I.A., Ghebreab S., Lamme V.A., & Scholte, H.S. (2012). Spatially pooled contrast responses predict neural and perceptual similarity of naturalistic image categories. *PLoS Computational Biology, 8*, 1-16.

Miller, M.A., & Fillmore, M.T. (2010). The effect of image complexity on attentional bias towards alcohol-related images in adult drinkers. *Addiction, 105*, 883-890.

Meyers-Levy, J., & Peracchio, L.A. (1995). Understanding the effects of color: How the correspondence between available and required resources affects attitudes. *Journal of Consumer Research, 22*, 121-138.

Oliva, A., & Torralba, A. (2001). Modeling the shape of the scene: A holistic representation of the spatial envelope. *International Journal of Computational Vision, 42*, 145–175.

Proulx, M.J., & Egeth, H.E. (2008). Biased competition and visual search: The role of luminance and size contrasts. *Psychological Research, 72*, 106–113.

Robbins, S.J., & Ehrman, R.N. (2004). The role of attentional bias in substance abuse. *Behavioral and Cognitive Neuroscience Reviews, 3*, 243–260.

Schoenmakers, T.M., de Bruin, M., Lux, I.F.M., Goertz, A.G., Van Kerkhof, D.H.A.T., & Wiers, R.W. (2010). Clinical effectiveness of attentional bias modification training in abstinent alcoholic patients. *Drug and Alcohol Dependence, 109*, 30-36.

Stormack, K.M., Laberg, J.C., Nordby, H., & Hugdahl, K. (2000). Alcoholics' selective attention to alcohol stimuli: automated processing? *Journal of Studies on Alcohol, 61*, 18–23.

Teunissen, H.A., Spijkerman, R., Vohs, K.D., Schoenmakers, T.M., & Engels, R.C.M.E. (2012). The effect of self-control on attentional bias for alcohol cues in male heavy drinkers. *Journal of Applied Social Psychology, 42*,776-792.

Townshend, J.M., & Duka, T. (2001). Attentional bias associated with alcohol cues: differences between heavy and occasional social drinkers. *Psychopharmacology, 157*, 67-74.

Turatto, M., & Galfano, G. (2001). Attentional capture by color without any relevant attentional set. *Perception and Psychophysics, 63*, 286-297.

(Manuscript received: 14 February 2013; accepted: 5 June 2013)