Investigating attentional bias in three differing alcohol consumption groups, and gender differentiation, utilising a visual dot probe

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ABSTRACT

Excessive alcohol consumption causes serious health problems. Research demonstrates that alcohol use is characterised by biases in the attentional processing of alcohol stimuli.

This study investigated 97, 18-25 year olds from Manchester Metropolitan University. Participants were split into a *low* (1-10 units p/w), *moderate* (11-20 units p/w), and *high* (21-30 units p/w) drinking group according to their response to the weekly alcohol indicator. Participants completed a dot probe task to elicit attentional bias towards alcohol stimuli.

Part 1 aimed to determine whether *moderate* and *high* drinkers display an attentional bias for alcohol stimuli. *Part 2* aimed to determine whether females had a higher attentional bias than males, in the *heavy* drinking group.

Results indicated that *moderate* and *high* drinkers displayed a significant attentional bias towards alcohol stimuli. However, a significant difference between male and female attentional bias index scores in the high drinking group was not identified. Findings support addiction theories, where attention gained by one stimulus decreases the attention to another.

Findings from this study can notify health professionals that the focus of interventions needs to not only target heavy drinkers, but moderate drinkers as well in order to reduce the escalation of drinking behaviour.

KEY WORDS:	ATTENTIONAL BIAS	ALCOHOL	DOT-PROBE TASK	MODERATE DRINKERS	GENDER

Introduction

Excessive alcohol abuse is a serious ongoing public health problem, with wide acknowledgements that consistent alcohol consumption is associated with a range of health conditions such as liver cirrhosis and cancer (British Medical Association, 2008). The annual cost of alcohol misuse in England and Wales has been estimated at £25 billion (Sheron *et al*., 2011). As well as alcohol use being associated with physical health decline and disease, alcohol use also has a significant effect on cognitive and attentional processes.

Research suggests that substance use is characterised by biases in the attentional processing of substance related stimuli , that is, substance-related stimuli acquire the ability to grab the users attention (Field & Cox, 2008). Thus attentional bias is 'a phenomenon where by attentional channelling is directed towards personally valued stimuli, despite an individual's efforts to ignore them' (Williams *et al*., 1996, p.3). Therefore it is fair to suggest that attention is not evenly distributed, in that the attention gained by one stimuli decreases the attention to another (Mathews & Macleod, 2002).

Several theories have provided explanations for the acquirement of an attentional bias from substance use and addiction. Classical conditioning theory posits that through the process of conditioning, 'a substance can be associated with environmental stimuli that are contiguous with and contingent on the effects of a specific substance' (Fields & Cox, 2008, p.8). As a consequence the individual orients their attention towards a predictive conditioned stimuli when it is experienced in the environment (Bindra, 1974; Pearce & Bouton, 2001) due to availability expectancy (Robinson & Berridge ,1993, 2001).

A motivational perspective focuses on goal pursuit (Bindra,1992; Toates, 1994; Cox & Klinger, 1988, 2004) ,an individual's motivational state biases attentional processing towards substance-related stimuli. The goal of using acts as a continuous distraction, thus causing the individuals attention to be continuously directed towards attaining their goal by selectively and automatically responding to substance-related stimuli (Klinger & Cox, 2004).

The integrated theories of addiction consider conditioning with cognitive neurobiological psychological perspectives. The incentive-sensitization model (Robinson & Berridge, 1993, 2001) posits that drug use causes lasting neuro-adaptations in the brain. A sensitised dopaminergic response for a substance and related stimuli is caused by frequent intermittent consumption of the substance (Robinson & Berridge, 1993, 2001). Such a sensitised response dictates an interpretation of the substance to be salient and acquire strong motivational properties (Field & Cox, 2008; Field *et al*., 2009). However the ability of a drug to induce sensitization is powerfully modulated by associative learning (Robinson & Berridge, 2001). Thus through mechanisms of classical conditioning, substance-related stimuli induce dopaminergic responses (Di Ciano *et al*., 1998). A consequence of this is that it 'grabs attention, becomes attractive and wanted', and thus guides behaviour to the incentive (Robinson & Berridge, 1993, p.5) leading to the development of attentional bias (Duvauchelle *et al*., 2000). As a consequence , attentional biases are strongly associated with drug seeking behaviour (Field & Cox, 2008).

Subjective craving is a continuous measurable state (Franken, 2003) that is considered a central phenomenon for continuing drug use (Everitt, 1997). Research utilising social drinkers demonstrates a positive correlation between attentional bias and subjective craving (Field *et al*., 2004; Field *et al*., 2005; Vollstadt-Klein, 2011). Franken (2003) suggests that attentional bias and subjective craving exist within a mutual excitatory relationship. Subjective craving increases when attention is focused on substance-related stimuli, and in turn the salience of such substance-related stimuli is increased. Attentional bias has been theorised as being caused by, and an outcome of craving (Weinstein & Cox, 2006), such a notion is supported by Ryan (2002) and Kavanagh *et al* (2005).

Various methods have been utilised to measure substance- related attentional bias such as the addiction Stroop task (Stroop, 1935) and the visual dot- probe (MacLeod *et al*., 1986). During the Stroop task an attentional bias is inferred when an individual's performance on the primary task is impaired in the presence of substance-related stimuli (Field & Cox, 2008). However varying Stroop interference results across studies may be due to carry over effects (Waters *et al*., 2005) and differing presentation formats (block/mixed presentation) (Waters & Feyerabend, 2000). Furthermore results from the Stroop task may not be explained as an 'attentional bias', but as a generic cognitive slowdown due to craving (Field & Cox , 2008).

The visual dot-probe is a direct measure of visuo-spatial attentional allocation **(**Macleod *et al*., 1986). Substance-related stimuli and control stimulus are simultaneously presented on a screen, participants are instructed to respond to the probe replacing one of the stimuli. Koster *et al* (2004) stated that response times will be faster when the probe appears in a spatial location where attention is already allocated. Thus it is assumed that substance-users relative to non-substance users will be quicker to respond a dot-probe replacing substance-related stimuli, hence forth demonstrating an attentional bias for substance-related stimuli (Field & Cox , 2008).

Stimulus presentation times (stimulus onset asynchrony), appear to be an important parameter when measuring attentional bias, as times ranging from 17-2000 ms have produced conflicting results (Field & Cox , 2008). Noel *et al* (2006) found an attentional bias in abstinent alcoholics at 50 ms but not at 500 ms, whereas Field *et al* (2004) found an attentional bias in heavy drinkers at 500 ms but not at 200 ms. Short stimulus onset asynchrony's (SOA) elicit biases in initial orientating (Duncan *et al*., 1994),whereas long SOA's elicit biases in disengagement. Despite slight variation in results, the visual dot probe task has successfully measured attentional bias towards various addictive substances such as opiates (Constantinou *et al*., 2010; Garland *et al*., 2012), cocaine (Tull *et al*., 2011), tobacco (Ehrman *et al*., 2002), alcohol (Townshend & Duka, 2007) and ketamine (Morgan, 2008).

Placing research within the field

A vast amount of research demonstrates the presence of an attentional bias for alcohol-related stimuli in heavy drinkers relative to light drinkers utilising the addiction Stroop task (Sharma *et al*., 2001; Lusher *et al*., 2004; Fadardi & Cox, 2006; Field *et al*., 2007). Utilising a pictorial dot probe task, Field *et al* (2011) found that heavy social drinkers demonstrated an attentional bias towards alcohol -related stimuli. Such findings are supported by Field *et al* (2013) who also found that abstinent alcoholic patients exhibited a greater attentional bias towards alcohol-related stimuli relative to social drinkers.

Leading on from this, Townshend & Duka (2001) investigated attentional bias in relation to alcohol in a non-clinical sample utilising a visual dot probe task. Participants were split into heavy (25 units per week) and light drinking groups (no specification). Mean bias scores indicated that heavy social drinkers showed an attentional bias towards alcohol related stimuli in comparison to light drinkers.

Similarly Field *et al* (2004) compared heavy (at least 20 units per week) and light (less than 10 units per week), establishing that heavy drinkers displayed an attentional bias for alcohol-related stimuli in comparison to light drinkers. Moreover, it is commonly suggested that the degree of an attentional bias is proportional to the quantity and frequency of alcohol consumption (Field & Cox, 2008). The aforementioned studies highlight a need to investigate, a previously unconsidered, *moderate* alcohol consumption group of 11-20 units per week. Such an investigation has been prompted by the notions of Robinson & Berridge's (1993) incentive-sensitisation theory which predicts that attentional bias develops gradually with each subsequent use. Thus there is a feasible expectation for the presence of an attentional bias in the moderate drinking group.

Leading on from this, based on the knowledge of the mutual excitatory relationship between attentional bias and subjective craving (Franken, 2003; Ryan, 2002). It is important to ascertain whether moderate drinkers do posses an attentional bias for alcohol-related stimuli because such biases induce subjective craving and vice-versa. Thus increasing the potential of alcohol seeking and using behaviour which may become problematic. The presence of such a bias is associated with the maintenance of addictive behaviour (Fadardi & Cox, 2009), therefore if we are aware of an attentional bias in *moderate* drinkers then alcohol attentional control training programmes (AACTP) can be utilised within this group, in order to reduce further increase in alcohol consumption.

The utility of AACTP has been demonstrated with the reduction of alcohol attentional bias in harmful and hazardous drinkers (Schoenmakers *et al*., 2007 ; Fadardi & Cox, 2009). Fadardi & Cox (2009) found a post attentional training reduction in alcohol consumption in the harmful drinkers group. Moreover, Schoenmakers *et al* (2010) found that attentional bias modification training was effective in increasing abstinent alcoholics ability to disengage from alcohol related cues, thus further demonstrating the effectiveness of attentional bias modification training.

Investigating potential gender differentiation

Alcohol consumption is also associated with deficits in response inhibition (Noel & Van Der Linden *et al*., 2005; Hildebrandt *et al*., 2004). Response inhibition refers to the mechanism of inhibiting approach tendencies to rewarding, appetitive stimuli (Nederkoorn *et al*., 2009). Such a notion is supported by Goldstein and Volkow (2002) who found that drug users display reduced inhibitory responses to stimuli that are associated with their substance of abuse.

Townshend & Duka (2005) found that in comparison to non binge drinking females, female binge drinkers displayed stronger deficits in inhibitory control function. However this was not found in males. Leading on from this ,during a modified stop signal task heavy drinking women displayed poorer response inhibition in comparison to light drinking women, and in comparison to light and heavy drinking males (Nederkoorn *et al*., 2009). Furthermore, utilising an alcohol go/no-go task Kreusch *et al* (2013) found that female problem drinkers displayed greater rates of false alarm errors for no-go alcohol stimulus relative to male problem drinkers, however it must be considered that the effect was close to statistical significance (p=0.052). Such results indicate cognitive differences between males and females, specifically heavy drinking male and females.

Based on the aforementioned evidence of cognitive deficits in response inhibition in the high drinking female population, it is feasible to consider that there may be similar cognitive deficits in attentional bias . Thus highlighting a need to consider gender as a potentially impacting variable on attentional bias when drinking at a high level.

Hypotheses

Part 1

1. It is hypothesised (One-Tailed) that individuals in the *high* drinking group will display an attentional bias, as indicated by faster reaction times, towards alcohol related stimuli in comparison to neutral stimuli, and in comparison to the *low* and *moderate* group.

2. It is hypothesised (One-Tailed) that individuals in the *moderate* drinking group will display an attentional bias, as indicated by faster reaction times, towards alcohol related stimuli. In comparison to neutral stimuli, and in comparison to the *low* group.

Part 2

3. It is hypothesised (One- Tailed) that females in the *high* drinking group will demonstrate a greater attentional bias, as indicated by faster reaction times towards alcohol-related stimuli. In comparison to males in the *high* drinking group.

Method

Design

A mixed-experimental design is utilised for both ***part 1*** and ***part 2***. An experimental design has been selected for the purpose of this research as experimental designs allow a causal relationship between variables to be identified (Breakwell *et al*., 2012).

Part 1 is a 2x3 mixed-experimental design. The between subjects independent variable is average weekly alcohol consumption (AWAC) (1-10 units per week (*low*), 11-20 units per week (*moderate*) , 21-30 units per week (*high*)).The within subjects independent variable is dot probe location, *congruent* (dot probe replaces alcohol-related stimuli), and *incongruent* (dot probe replaces neutral stimuli). The dependent variable is reaction time on the dot probe task (in milliseconds).

Part 2 is a mixed-experimental design . The between subject independent variable is gender (male or female), and the dependent variable is the attentional bias index score of the *high* alcohol group, 21-30 units per week.

Participants

Participants for this study were recruited via an opportunity sampling method. A specific target population of individuals who drink a minimum of one alcoholic beverage per week (Neederkoorn, 2009) and a target population age range of 18-25 years was utilised. Posters were displayed around Manchester Metropolitan University Psychology department inviting individuals to take part in this research. A power analysis was conducted using G*Power 3.1.3 (Faul *et al*., 2007) at a significance level of 0.5,a power of .80 and a small effect size (Cohen's d =.25) ,which determined a minimum sample size of 60 participants.

Part 1 utilised 97 individuals who were split according to weekly alcohol consumption into a *low* (*N*=24), *moderate* (*N*=53) and *high* (*N*=40*)* group. ***Part 2*** utilised the dot probe data from the *high* drinking group (*N*=40) from ***Part 1***. The *low* drinking group had a mean age of 21.6 years, the *moderate* drinking group had a mean age of 21.4 years and the *high* drinking group had a mean age of 21.8 years.

Apparatus

A short form questionnaire (*Appendix* 5) requiring participant number, gender, age and the quantity of alcohol consumed on average per week was utilised for the research. Alcohol consumption was indicated by ticking one of three average weekly alcohol indicators (AWAI): 1-10 units per week (*low)*, 11-20 units per week (*moderate*) and 21-30 units per week (*high)*. Participants were provided with a 'unit conversion chart' within the questionnaire in order to convert their weekly drinks into units with ease (*Appendix* 5). 1-10 units per week and 21-30 units per week are categorisations of light/heavy drinkers successfully utilised in previous research (Duka *et al*., 1999; Field *et al*., 2004), and have been used to define the *moderate* group (11-20 units per week) for this research.

Moreover, an information sheet (*Appendix* 2) was constructed to explain the process of the research, and an informed consent form ,which included the participants identification number and a signature box (*Appendix* 3). The information sheet and the informed consent form contained ethical inclusions such as data protection, the right to withdraw and anonymity. Furthermore, standardised task instructions (*Appendix* 9) were administered to explain the procedure of the computerised task.

A pictorial visual dot probe task (MacLeod *et al*., 1986) was utilised to measure and elicit attentional bias towards alcohol related stimuli. A visual dot probe task was selected for use in order to address the research aims ,as it allows the distribution of visual attention to be assessed. Furthermore, the results of the dot probe will allow the presence of an attentional bias to be defined (Townshend & Duka,2001). Moreover, research has demonstrated the dot probe to be a successful method of measuring attentional bias in relation to alcohol (Townshend & Duka, 2001; Field *et al*., 2004; Field *et al*., 2005).

The pictorial dot probe task consisted of 56 images sourced from various websites. 24 images of alcohol related stimuli such as pints/bottles of beer, wine glasses/bottles, spirit bottles and pub signs (Kreusch *et al*., 2013) (*Appendix* 6a & 6b) , and 32 images of household objects (*Appendix* 7) were utilised. Alcohol pictures were selected for use as stimuli opposed to words, as pictorial stimuli induce better reward related responses associated with the development of an attentional bias, further more pictorial stimuli are also considered to be more ecologically sound (Bruce & Jones, 2004; Townshend & Duka,2001).

The pictorial dot probe task software was designed by a Manchester Metropolitan University (MMU) computer technician. The pictorial stimuli utilised within the dot probe task were edited to a standardised size of 100mm x 125mm (Field *et al*., 2005) and changed to gray scale in order to ensure consistency between pictorial stimuli.

The task began with standardised onscreen instructions (*Appendix* 8) which allowed the participant to initiate the task once ready, and complete 4 practice trials utilising 4 pairs of household/office images in order to familiarise themselves with the task lay out. Moreover, pictorial stimuli for the test trials were organised into 24 pairs; one alcohol-related image (*congruent*) and one neutral image (*incongruent*), and were presented in a semi random manner to ensure that dot probes did not appear consecutively in the same location.
A 20mm central fixation cross appeared on screen for 500 m/s followed by an image pair presented for 500 m/s (Townshend & Duka, 2001; Field *et al*., 2004; Field, Mogg & Bradley, 2005). One image appeared on the left of the visual display , and one image appeared on the right of the visual display. After the 500 m/s presentation time, both images disappeared and one image was immediately replaced by a dot probe, which remained until a response was made regarding the dot probe location. The 'F' key was utilised to respond to the

dot probe appearing on the left of the visual display, and the 'k' key was utilised to respond to the dot probe appearing on the right of the visual display. Each image pair was presented four times, once for each possible presentation variable; picture location, left/right and dot probe location, *congruent*/ *incongruent*; totalling 96 presentations.

The dot probe software recorded response times for *congruent* (alcohol-related stimuli) and *incongruent* (neutral stimuli) which were transferred automatically to a data spread sheet. The software also recorded error rates for all 96 trials. An attentional bias is inferred by a faster response time when the visual dot probe replaces alcohol related stimuli (*congruent*) in comparison to neutral stimuli (*incongruent*).

All participants were issued with a debrief form (*Appendix* 4) which included an overview of the study aims, researcher contact details, and the reinstating of the right to withdraw.

Ethical Considerations

This research has been conducted in accordance with the British Psychological Society code of ethics and conduct (BPS, 2009). The structure of the codes are based on four ethical principles; respect, competence, responsibility and integrity. Furthermore, this research has been carried out alongside MMU departmental ethical guidelines and an AEAF form has been completed and discussed with a supervisor (*Appendix* 1). In reference to this research, no special considerations were required to work with such participants.

Moreover, participants were provided with an information sheet (*Appendix* 2), provided informed consent by signing the consent form (*Appendix* 3) and were given the right to withdraw at any point. Participant information and data was protected, participant identity and participant data remained anonymous by utilising participant numbers when discussing task findings. Furthermore, participants were administered with a debrief form (*Appendix* 4) outlining the research aims, reinstating their right to withdraw, and contact details of relevant MMU support services.

Procedure

Participants received a information sheet (*Appendix* 2) and an informed consent form (*Appendix* 3), including their participant number and required consenting signature. Participants were then administered with a questionnaire (*Appendix 5*) which recorded their average weekly alcohol consumption ,age and gender. After reading the information sheet, signing an informed consent form and completing a questionnaire, participants sat at a desk in front of a laptop.

In order to reduce any potential extraneous variables the task was completed by each participant at the same desk and laptop arrangement within a quiet environment. Participants viewed onscreen instructions (*Appendix* 8), stated their participant number and completed a practice trial followed by the actual 96-

trial dot probe task. Moreover, task instructions (*Appendix* 9) were also placed next to the laptop in paper form to ensure clarity of expected task procedures .
The use of standardised instructions reduces the chance of potential investigator effects and ensures equality between participants. Participants responded to the dot probe locations as quickly as possible utilising the instructed response keys, which were each highlighted with a florescent pink sticker for clarity of response key location. Upon completion of the task a message appeared to inform the researcher and a debrief form (*Appendix* 5) was administered.

Results

Study 1

Reaction time (in milliseconds) for the detection of dot probe position, whether *congruent* (replacing alcohol-related stimuli) or *incongruent* (replacing neutral stimuli) as recorded for *low* (n=24), *moderate* (n=32) and *high* (n=40) alcohol consumption groups, utilising a visual dot probe task were entered into SPSS 19.

Preparation of Data

The data was screened for reaction times below 200ms or more than 2000 ms (Townshend & Duka, 2001) however no participants fell into this category. No participants were removed due to incorrect responses. Participant 4 was removed due to the fact that their reaction time was 3 standard deviations above the mean (Field *et al.,* 2004). All analysis and graphs were derived from SPSS outputs (*Appendix 10*).

Table 1 provides mean reaction times (in milliseconds) and standard deviations for the three alcohol groups when the dot probe replaced alcohol-related stimuli (*congruent*) and neutral stimuli (*incongruent*).

Table 1: Mean response times (in milliseconds) and Standard Deviations for each group to respond to dot probe.

	Low *M (SD)*	**Medium** *M(SD)*	**High** *M(SD)*	**Whole sample** *M(SD)*
Congruent	.392 (.04)	.399 (.04)	.388 (.03)	.393 (.04)
Incongruent	.405 (.06)	.476 (.07)	.506 (.07)	.470 (.08)

A 2x3 Mixed Factorial ANOVA was performed , an ANOVA is an analysis of variance which tests for differences between groups (Dancey & Reidy, 2011). The within-subjects independent variable was dot- probe position (*congruent* and *incongruent*), the between- subjects independent variable was alcohol group (*low*, *moderate*, *high*), and the dependent variable was time taken to respond to probe location (in milliseconds). A significant main effect was found for dot probe position, $F(1,93) = 121.86$, $p < .001$. A significant main effect for alcohol was also identified, $F(1,93) = 8.92$, $p <.001$. Furthermore, a significant interaction effect was found, $F(1,93) = 23.61$, $p <.001$.

Figure 1. demonstrates the significant interaction effect found.

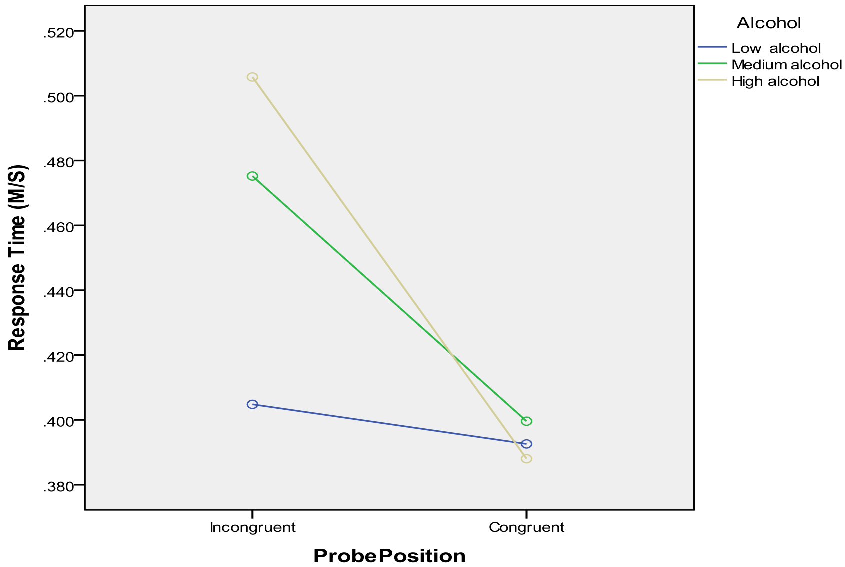

Figure 1 is a means plot to demonstrate the significant interaction between participant group (*Low, Moderate, High*) , and dot probe position (*congruent/incongruent).*

As a significant interaction was found within the ANOVA, Post Hoc tests were performed to analyse the interaction indentified. 3 paired-samples t-tests and 3 independent sample t-tests were conducted. Thus, a Bonferroni Correction was required to control for familywise error rates for 6 pair wise comparisons , (.05/6=.0083) sets a new alpha significance level of $p <.0083$ (Welkowitz *et al*., 2012).

The first paired- samples t-test was for the *high* alcohol group, where the independent variable was dot probe position (*congruent /incongruent*) and the dependent variable was reaction time (in milliseconds). The *high* alcohol group demonstrated a significant difference in dot probe reaction times in *congruent* and *incongruent* positions, $t(39) = 12.84$, $p <.0083$, [1]d=2.23, this shows a large effect size. *High* alcohol users responded significantly faster to the probe in *congruent* (M=.388) in comparison to *incongruent* (M=.506) positions.

The second paired-samples t-test was for the *moderate* alcohol group, where the independent variable was dot probe position (*congruent/incongruent*) and the dependent variable was reaction time (in milliseconds). The *moderate* alcohol group demonstrated a significant difference in dot probe reaction times

[1] It is suggested that when a statistically significant effect is reported, an effect size should also be reported. A measure of effect size is intended to provide a measurement of the absolute magnitude of an effect (Gravetter & Wallnau, 2013). A method for assessing effect size which has been utilised within this report is *Cohen's d.* Cohen (1992) suggested that effect size can be standardised by measuring the mean difference in terms of standard deviation. Cohen (1992) suggested a criteria for evaluating the size of effect: d = 0.2 is a small effect size, d = 0.5 is a medium effect size, and d = 0.8 is a large effect size.

in *congruent* and *incongruent* positions, *t*(31) = 6.12, *p* <. 0083, *d* =1.31, this shows a large effect size. *Moderate* alcohol users responded significantly faster to the probe in *congruent* (*M*=.399) in comparison to *incongruent* (*M*=.475) positions.
The third paired-samples t-test was for the *low* alcohol group, where the independent variable was dot probe position (*congruent*/*incongruent*) and the dependent variable was reaction time (in milliseconds). The *low* alcohol group did not demonstrate a significant difference in dot probe reaction times in *congruent* (*M*=.393) and *incongruent* (*M*=.404) positions, *t*(23) = 1.31, *p* >.0083, *d* = 0.24, this shows a small effect size.

An attentional bias index score (ABI) was calculated for use as the dependent variable in the independent samples t-tests. The ABI was calculated by subtracting the mean *congruent* reaction time from the mean *incongruent* reaction time (Townshend & Duka, 2001). A positive ABI score demonstrates an attentional bias towards alcohol related stimuli, opposed to a negative ABI score which indicates avoidance of alcohol related stimuli (Koster *et al*., 2004). Furthermore, a greater attentional bias index score indicates a larger attentional bias towards alcohol-related stimuli.

The first independent sample t-test was to compare ABI scores, where the independent variable was alcohol group (*low* and *high)* and the dependent variable was ABI score. Levene's test for equality of variance was significant, thus equal variances were not assumed. The ABI score was significantly different between the *low* and *high* alcohol group, *t*(57.82) = 8.13, *p* <.0083,*d* = 2.02, this shows a large effect size. The *high* alcohol group had a significantly higher ABI score (*M*=.117) than the *low* alcohol group (*M*=.012).

The second independent sample t-test was to compare ABI scores, where the independent variable was alcohol group (*medium* and *high)* and the dependent variable was ABI score. Levene's test for equality of variance was not significant, thus equal variances were assumed. The ABI score was significantly different between the *moderate* and *high* alcohol group, *t*(70) = 2.80, *p* <.0083, *d* = 0.64, this shows a medium effect size. The *high* alcohol group had a significantly higher ABI score (*M*=.117) than the *moderate* alcohol group (*M*=.076).

The third independent sample t-test was to compare ABI scores, where the independent variable was alcohol group (*low* and *moderate)* and the dependent variable was ABI score. Levene's test for equality of variance was significant, thus equal variances were not assumed. The ABI score was significantly different between the *low* and *moderate* alcohol group, *t*(52.94) = 4.12, *p* <.0083, *d* = 1.09, this shows a large effect size. The *moderate* alcohol group had a significantly higher ABI score (*M*=.076) than the *low* alcohol group (*M*=0.12).

Study 2

A further independent t-test was performed, where the independent variable was gender (*male*/*female)* and the dependent variable was ABI score, using data only from the *high* drinking group. Analyses revealed that there was no significant difference between *males* (*M*=.019) and *females* (*M*=.008), whilst *males* had a slightly higher ABI score, this was not significantly so. Levene's test for equality of variance was not significant, thus equal variance was assumed, $t(22) = .602$, $p > .0083$.

Discussion

The present study ***part 1*****,** found that the *high* drinking group responded significantly faster to the dot probe in the *congruent* positions, than the *incongruent* positions. Moreover, the *high* drinking group responded significantly faster to the dot probe in the *congruent* position than the *moderate* drinking group. The present study further identified that the *low* drinking group did not demonstrate a significant difference in response times to the dot probe in *congruent* and *incongruent* positions.

Leading on from this, ***part 1*** found that the *moderate* drinking group responded significantly faster to the dot probe in *congruent* positions, then the *incongruent* positions. The present study further identified that the *moderate* drinking group had a significantly higher attentional bias index score than the *low* drinking group, thus demonstrating a larger attentional bias towards alcohol related stimuli.
Therefore, ***part 1*** successfully identified that *heavy* drinkers demonstrated a significant attentional bias towards alcohol-related stimuli in comparison to neutral stimuli, and in comparison to *low* and *moderate* drinkers. Furthermore, ***part 1*** successfully identified that *moderate* drinkers demonstrated a significant attentional bias towards alcohol-related stimuli in comparison to neutral stimuli, and in comparison to *low* drinkers. Thus, the above findings support **hypothesis 1** and **2**.

The findings from ***part 1*** are supported by the motivational model of addiction (Bindra, 1992; Cox & Klinger, 1988, 2004; Toates, 1994), in that the motivational state of the individual biases their attention towards attaining their goal by selectively and automatically responding to substance related stimuli (Klinger & Cox, 2004). Leading on from this, findings from ***part 1*** also provide support for the incentive-sensitisation (Robinson & Berridge, 1993, 2001) model of addiction, which posits that a sensitised dopaminergic response for a substance and substance-related stimuli, induced by frequent use of a drug, dictates a salient interpretation of the substance. Thus behaviour is guided towards the incentive (Robinson & Berridge, 1993, 2001) which leads to the development of an attentional bias for such a substance (Duvauchelle *et al*., 2000).

The presence of an alcohol-related attentional bias in the *high* and *moderate* alcohol group is supported by Mathew & Macleod (2002) who stated that the attention gained by one stimulus decreases the attention to another, thus resulting in faster reaction times to alcohol related stimuli. Leading on from this the presence of an attentional bias towards alcohol-related stimuli in the *high* drinking group is consistent with many similar studies (Fadardi & Cox, 2006; Field *et al.,* 2013; Field *et al.,* 2011; Field *et al.,* 2004; Lusher *et al.,* 2004; Sharma *et al.,* 2001; Townshend & Duka, 2001).

Part 1 findings highlighted the presence of a significant attentional bias towards alcohol-related stimuli in the *moderate* drinking group, which has not been previously investigated or identified in attentional bias research. The presence of an attentional bias in the *moderate* drinking group may be explained by the notions of Robinson and Berridge's (1993) incentive-sensitisation theory, which posits that an attentional bias develops progressively with each subsequent substance use. Much of the previous research put forward the notion that the degree of an individual's alcohol-related attentional bias is proportional to the quantity and frequency of alcohol use (Field & Cox, 2008; Field *et al.,* 2004; Townshend & Duka, 2001), this appears to support and explain the findings of ***part 1***.

In support of the notion that attentional bias is proportional to the quantity of alcohol use, the attentional bias identified in the *high* drinking group was larger, as indicated by a slightly faster response time to the probe in the *congruent* position, than the attentional bias in the *moderate* group. Moreover, the progressive increase in attentional bias towards alcohol-related stimuli between the *moderate* and *high* drinking group thus demonstrates the notion of a progressive development of attentional bias, encapsulated within the incentive-sensitisation theory (Robinson & Berridge, 1993, 2001).

Leading on from this, the presence of an alcohol-related attentional bias in the *moderate* and *high* drinking group, which became progressively larger according to drinking group, could also be explained by the model put forward by Franken (2003). Such a model suggests that attentional bias and subjective craving exist within a mutually excitatory relationship. The presence of an attentional bias leads to subjective craving for the substance, and in a reciprocal manner, subjective craving leads to an increased attentional bias for the alcohol-related stimuli (Weinstein & Cox, 2006). Franken's (2003) model appears to explain and support the findings from ***part 1***.

The identification of an alcohol-related attentional bias within the previously unexplored *moderate* drinking group highlights an 'at risk' population to health professionals. The presence of an attentional bias is associated with the maintenance of addictive behaviours (Fadardi & Cox, 2009) and are strongly associated with drug seeking behaviour (Field & Cox, 2008). Thus, both *moderate* and *high* drinking group individuals have the potential to engage in more dangerous levels of drinking behaviour, through the reciprocal relationship between attentional bias and subjective craving (Franken, 2003; Kavanagh *et al*., 2005; Ryan, 2002).

The findings from this research reinstate a need for health professionals to target both *moderate* and *high* range drinkers. In order to implement interventions that target alcohol-related attentional biases, and reduce potential escalation of drinking behaviours. The use of alcohol attentional control training programmes (AACTP) have been successfully utilised in reducing alcohol-related attentional biases in harmful drinkers (Fadardi & Cox, 2009; Schoenmakers *et al.,* 2007) and abstinent alcoholics (Schoenmakers *et al.,* 2010). Thus AACTP may be appropriate for the treating the populations discussed within this research. Moreover, the results from ***part 1*** could be confidently generalised to the wider student population.

Part 2 aimed to identify whether females in the *high* drinking group displayed a greater attentional bias than males in the *high* drinking group. Findings indicated that in fact males displayed a greater alcohol-related attentional bias, however such a difference was not statistically significant. Therefore **hypothesis 3** was not supported.

The findings from ***part 2*** contradicted the notion that there may be cognitive differences between male and female heavy drinkers. Poorer inhibitory control function found in female heavy drinkers , but not in male heavy drinkers (Kreusch*.,* 2013; Nederkoorn *et al.,* 2009; Townshend & Duka, 2005) prompted the notion that similar cognitive deficits may be found in attentional bias for females, however ***part 2*** research findings did not support such a notion.

A potential explanation for the presence of a higher attentional bias in high drinking group males, opposed to the hypothesised high drinking group females, albeit a insignificant difference, may relate to the idea of current concern (Klinger & Cox, 2004). A vast number of the alcohol stimuli utilised within the dot probe were related to beer ,which may be interpreted as more male orientated. Thus if the alcohol stimuli did not sufficiently relate to the females current concerns, and related more to a male current concern, then this would provide a feasible explanation as to why males in the high drinking group displayed a greater alcohol-related attentional bias than females. However it must be reinstated that the difference was not statistically significant, thus gender does not appear to be an impacting variable on attentional bias.

Real- World Implications of Findings

The research findings indicate an alcohol- related attentional bias in the *moderate* and *high* drinking group. As previously discussed, such knowledge can guide health professionals and emphasises a need for not only the drinking behaviours of heavy drinkers to be at the focus of interventions, but also *moderate* drinkers too. The presence of an attentional bias is associated with the maintenance of addictive behaviours (Fadardi & Cox, 2009). Thus, via the mutually excitatory relationship between attentional bias and subjective craving, both population groups pose a risk of increased drinking behaviour that must be targeted.

Limitations

One limitation of this research is that the use of a specific sample criteria of 18-25 year old individuals who drink a minimum of one alcoholic beverage a week, from Manchester Metropolitan university dictates that such findings can only be generalised to the wider student population, and not the general population.

Strengths

A strength of this study is that it has identified an attentional bias in a previously unexplored population, *moderate* drinkers. A further strength is that the research findings can notify health professionals of a need to target *moderate* drinkers ,as well as *high* drinkers during intervention. Moreover, the use of a robust sample size adds strength to the findings of this research.

Future Research

In light of carrying out this research, it would be beneficial for future studies to utilise word stimuli as well as pictorial stimuli to assess whether an attentional bias in the *moderate* drinking group is still identified with the use of word stimuli. Moreover, future studies should investigate non-student populations, in conjunction with varying SOA's. Furthermore, there is limited research on the efficacy of attentional retraining programmes , thus future research should focus on the efficacy of such programmes to reduce alcohol-related attentional bias in *moderate* and *high* drinking individuals. Explorations into the area of attentional retraining would provide insight into the methods that could be deemed effective at reducing the widely documented phenomenon of alcohol-related attentional biases.

Conclusion

In conclusion, findings implicate strong evidence that *moderate* alcohol consumers (11-20 units p/w) and *high* alcohol consumers (21-30 units p/w), elicit an attentional bias towards alcohol- related stimuli in comparison to neutral stimuli. Moreover, such an alcohol-related attentional bias appears to increase according to alcohol consumption group. However, a significant difference between male and female attentional bias scores in the *high* drinking group was not identified.
Leading on from this, the identification of an alcohol-related attentional bias in both the *moderate* and *high* drinking group within this research highlights two population groups that are at significant risk of increased drinking behaviour. Such findings should urge health professionals to put into place appropriate interventions to reduce alcohol -related attentional bias so that drinking behaviour does not increase.

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